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POSITION PAPER FROM THE CONFERENCE:

NITROGEN REMOVAL ONSITE WASTEWATER TREATMENT SYSTEMS: TECHNOLOGIES AND REGULATORY STRATEGIES

February 27 & 28, 1992

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In addition, WBNERR thanks the following for their support of this effort:

Stephen P. Dix, U.S. E.P.A. National Small Flows Clearinghouse
The U.S. Environmental Protection Agency.
The Massachusetts Bays Program.
The Buzzards Bay Project.
The Massachusetts Coastal Zone Management Agency.
The Cape Cod Commission.
The Barnstable County Department of Health and Environment.
The Citizens for the Protection of Waquoit Bay
The Woods Hole Oceanographic Institution, Coastal Research Center
Congressman Gerry Studds
The Massachusetts Department of Environmental Protection
The Massachusetts Department of Environmental Management
The New England Interstate Water Pollution Control Commission
The Cape Cod Commission
The Falmouth Jewish Congregation
Our many volunteers who helped us with logistics and organization.

The Waquoit Bay National Estuarine Research Reserve (WBNERR) is one of nineteen sites, nationally, that comprise the National Estuarine Research Reserve System. It is jointly funded and administered by the Sanctuaries and Reserves Division of the National Oceanic and Atmospheric Administration and by the Division of Forests and Parks within the Massachusetts Department of Environmental Management. WBNERR's primary goal is to protect the natural resources of estuaries. It seeks to achieve this goal via three avenues of activity: (1) Sponsoring applied estuarine research to enable us to better understand how to manage these ecosystems. (2) Facilitating the incorporation of current estuarine research results coastal zone policy development. (3) Educating local, regional, and state level regulators and managers, as well as the citizenry-at-large, about the relevant science and policy issues. The ultimate goal is responsible coastal zone management supported by a well informed citizenry.

Christine Gault - Reserve Manager

INTRODUCTION:

In recent decades, citizens and researchers have observed degradation in Waquoit Bay and similar, environmentally sensitive estuaries along the New England coast. These trends of degradation result largely from anthropogenic additions of nitrogen, much of which comes from septic tank effluent[1]. The Waquoit Bay National Estuarine Research Reserve (WBNERR) recently sponsored a conference on advanced onsite wastewater treatment systems to explore the potential for using such systems in coastal watersheds, as a component of comprehensive plans, to address the nitrogen loading problems.

The primary goal of the conference planning committee was to provide Massachusetts regulators and citizens with information about advanced onsite wastewater treatment technologies and regulatory strategies from persons in other states where these technologies are more widely used. The conference organizers hoped, too, that the various states represented would be able to learn from each other's presentations.

The conference, held on February 27 & 28, 1992, drew well over two hundred people each day. Attendees and speakers came from as far away as California, Florida, and Texas, and represented all levels of government, professional engineering and consulting firms, concerned residents, non-profit organizations, and civic associations.

This report summarizes and synthesizes key points expressed by invited speakers, main points of consensus from group work sessions, and closely related information from conversations and meetings surrounding the conference. It should not be thought of as a proceedings in the usual sense of the word. It is the author's intent both to represent accurately the sense of the conference and to provide interested parties with a cohesive document that ties together the primary concerns that people have raised around this issue.

Debate continues over a number of points raised in this paper, and it is **not** intended as a definitive statement of fact about wastewater treatment technologies. Rather, it represents the sense of the meeting, and information taken from presentations may not represent a consensus among all persons concerned with wastewater treatment. WBNERR hopes that it will serve as a point of departure for further discussion and thought.

Many of our reviewers suggested that a bibliography would be useful. Although we have followed this suggestion, little published information is available about nitrogen-removal wastewater treatment systems. Indeed, this dearth of literature provided impetus for the conference organizers to convene this symposium. We encourage interested readers to contact the persons listed in Appendix C for further information.

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[1] Buzzards Bay Project Comprehensive Conservation and Management Plan, Massachusetts Coastal Zone Management Agency, 1991; Valiela, I. and J. Costa, 1988. Environmental Management, Garber, J. Presentation at WBNERR onsite conference February, 1992.

I - NITROGEN

Why Are We Concerned About Nitrogen?

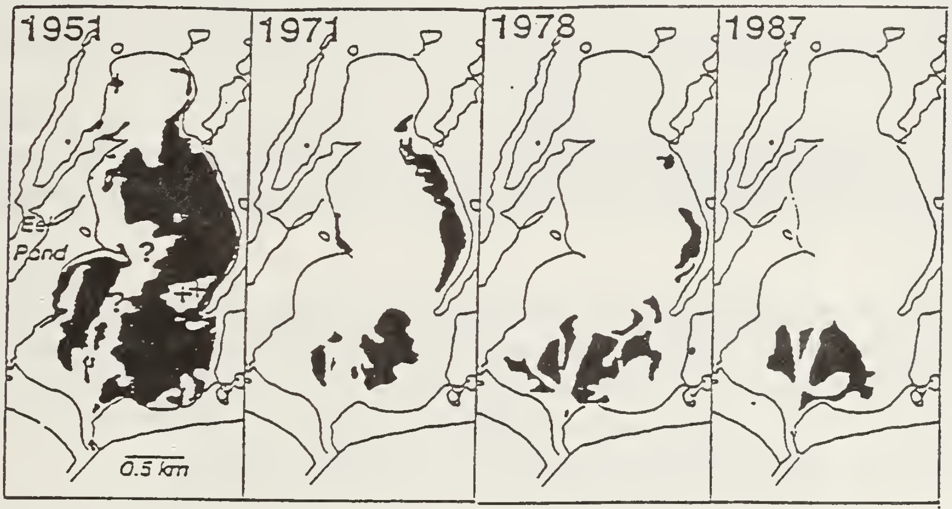
(Contributions from Dr. Jonathan Garber and Richard Voyer, U.S. E.P.A. Narragansett Environmental Laboratory.)

Based on studies which suggest that excessive amounts of nitrogen in drinking water pose a health risk to humans, the U.S. E.P.A. has set a drinking water standard of 10 ppm.[2] Surveys on Cape Cod routinely find nitrogen concentrations in drinking water wells that exceed this standard.

In addition, research in coastal marine environments continues to suggest that anthropogenic additions of nitrogen to embayments and salt ponds are responsible for a number of disturbing trends such as:

decreasing water quality (e.g., decreased water clarity, changes in patterns of dissolved oxygen fluctuations)
decreasing area of eelgrass beds, an important habitat for shellfish, finfish and scallop larvae
increasing incidence of fish kills
increasing abundance of macroalgae
changes in species composition

The maps below depict one graphic example.



Eelgrass beds (shaded areas) in Waquoit Bay declined 80%, between 1951 and 1987. The decline accompanied increases in development (and associated nitrogen loading) in the Waquoit Bay watershed.[3]

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[2] U.S. EPA, 1976; Winneberger 1982.
[3] Data from J. Costa.

We have yet to establish accepted nitrogen standards for surface waters, such as those that exist for drinking water. Some places have adopted concentration-based standards (e.g. 0.4 mg N/liter on Long Island)[4]. However, other studies and lines of argument suggest that these may not be adequately protective. Concentrations of nitrogen in coastal waters vary seasonally, concentrations in the water do not take into account nitrogen from recent development in groundwater that has not yet reached surface waters, and much of the nitrogen in macrophyte-dominated ecosystems may be sequestered in the algae.[5] The suggestion is that in many cases nitrogen loading standards should be based on a mass loading approach, looking at the total nitrogen expected to enter embayments based on land use in the drainage basins.

In general, the best available information suggests that critical loading rates for marine embayments will frequently be considerably lower than critical nitrogen concentrations based on drinking water standards. However, critical loading limits vary from one estuary to another depending upon flushing rate, depth, morphology, and species composition.

What is the Connection Between Nitrogen and These Trends?

Nitrogen is an essential nutrient and building block in living organisms. In coastal waters, the main factor limiting the growth of algae ("seaweeds") and phytoplankton is often the amount of nitrogen present. Hence, when ammonium and nitrate are added to marine ecosystems from human sources (we call this "nitrogen loading"), algae grow faster, and the amount of algae increases, with the following consequences.

First, algae block light from reaching eelgrass beds and thereby lead to eelgrass declines. The eelgrass provides important nursery and feeding habitat for finfish and shellfish, so declines in fish abundance and scallop harvests are probably related to the decline in eelgrass.

Second, algae photosynthesize during the day, producing oxygen, and respire at night, consuming oxygen. Hence, large mats of algae produce and consume large amounts of oxygen each day, and at certain times of year dramatically affect the levels of dissolved oxygen in the bay. Increased amounts of algae add to the likelihood of low-oxygen conditions, under which fish and shellfish die in large numbers.

Thus, it is not surprising that as nitrogen inputs to coastal waters have increased, water quality and related aspects of estuaries have declined.

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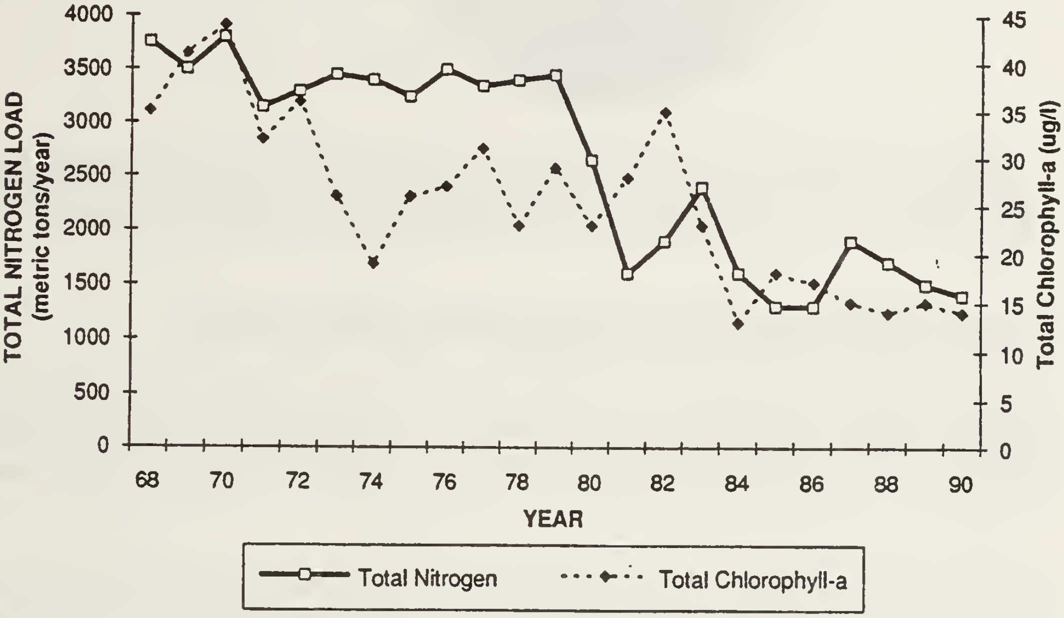
[4] Neilson, 1972.

[5] Dr. Joseph Costa, Director, Buzzards Bay Project, personal communication.

Does Reducing the Input of Nitrogen Improve Coastal Water Quality?

In Hillsborough Bay, Florida and Mumford Cove, Connecticut, reducing the amount of nitrogen entering coastal waters led to dramatic improvements in water quality within a few years. In Hillsborough Bay, nitrogen inputs to the bay remained high between 1968 and 1979. In 1979 a new wastewater treatment plant began operating, and the total concentration of chlorophyll-a dropped, as did the abundance of blue-green algae. Extreme concentrations of dissolved oxygen disappeared, and water clarity increased[6]. Examples like these, in combination with our understanding of the processes that are responsible for eutrophication,[7] suggest strongly that coastal ecosystems can recover from a history of excessive nitrogen inputs.



In Hillsborough Bay, Florida, levels of nitrogen entering the bay dropped dramatically in 1979 (solid line). By 1982, the amount of phytoplankton had begun to decline, following the decline in nitrogen inputs.[8]

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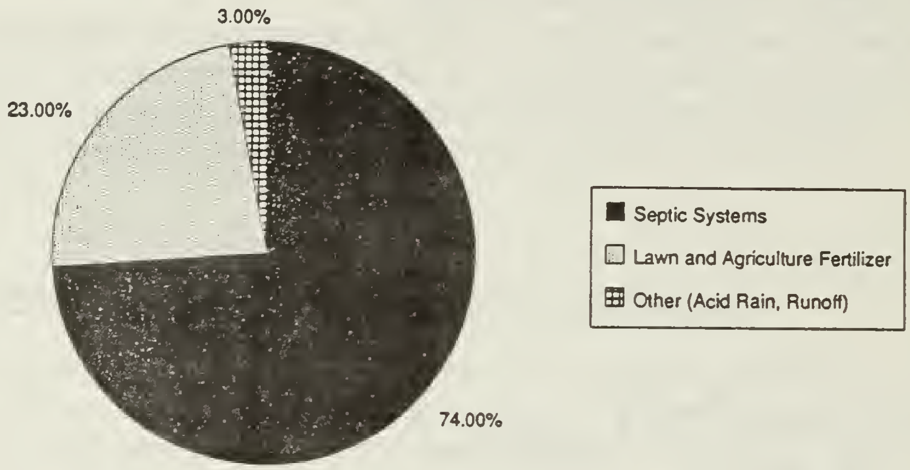
[6] Johansson, 1992.

[7] Eutrophication: the change in species composition and increases in phytoplankton and algae that accompany nutrient additions to surface waters.

[8] Johansson, 1992.

Where Does the Nitrogen Come From?

In Southern New England, onsite wastewater disposal at residences and businesses accounts for much of the nitrogen that ultimately enters coastal waters. Lawn and agricultural fertilizers also contribute significant amounts of nitrogen. Other sources include acid rain and runoff from roads and roofs.



Sources of Nitrogen Entering a Shallow Coastal Bay on Cape Cod

Studies by Horslev, Witten, & Hegemann, conducted for the Buzzards Bay Project, suggest that most of the nitrogen entering Buttermilk Bay originates from septic systems.

Why is There So Much Nitrogen in Septic Tank Effluent?

Nitrogen is a major component of plants and animals, and all the nitrogen that the organisms take in eventually leaves. "Worn-out" molecules that the body discards (in urine) as well as food that is not absorbed by the body (feces) contain large amounts of nitrogen.

Conventional septic tank systems are not designed to remove nitrogen from the waste before discharging it to the ground via the leach field. Some nitrogen may be stored in the septic tank and in the soil, and taken up by plants. However, the degree of removal is difficult to predict and may range from 10 to 40% of the total nitrogen in the wastewater. Estimates about how much nitrogen enters the groundwater from a typical septic system vary.[9]

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[9] Ayres Associates, 1991, pp. 12 - 18: Seigrist & Jenssen, 1989 cited in Ayres Associates, 1991.)

How Can We Limit Nitrogen Inputs to Coastal Salt Ponds and Bays?

There is no single solution. There are a number of technological and planning tools available to ensure that the total amount of nitrogen generated by human activity in homes and businesses in a coastal watershed does not cause unacceptable deterioration of the receiving waters. All of the available tools should be used in the context of logical, comprehensive planning.

One technological option is sewering and constructing large, advanced wastewater treatment plants with nitrogen-removal capabilities or with discharge pipes placed in an area where nitrogen is not of primary concern. Many central wastewater treatment facilities do not incorporate nitrogen removal capabilities. A second is small, community-based wastewater treatment plants, for either raw wastewater or effluent from conventional septic tanks that travels from the septic tanks through small diameter pipes. These technologies have many variations and can be designed to remove nitrogen. A third and important option is using advanced onsite wastewater treatment systems for the home. These systems (recirculating sand filters, peat filters, and composting toilets, to name a few) treat the wastewater where it is produced, at the home or business, hence the name "onsite" systems - and they discharge to the ground a much higher quality, lower nitrogen effluent than conventional septic tank-leach field technology.

II - WASTEWATER TREATMENT TECHNOLOGIES

Why Look At Advanced Onsite Wastewater Treatment Systems?

This particular solution has a number of advantages and presents a number of challenges. As we have stated previously, the authors do not intend to suggest that advanced onsite wastewater treatment systems are the only solution to the varied wastewater treatment problems that face communities. Our goal, rather, is to articulate the advantages that these particular technologies offer and to facilitate their consideration as important and viable options. Moreover, it should be recognized that while the points outlined below reflect the thoughts of some of those most knowledgeable about these systems, debate continues over some of the information we report.

First, compared to building or extending a central sewer system, advanced onsite wastewater treatment systems can be economical. One aspect of this economic advantage is the ability to match the number of systems to the size of the community. Central plants are generally built once, to accommodate wastewater flows from projected populations, and 60-80% of the cost rests in the sewers.[10] Since these projections are, by definition, uncertain, the plants and collection systems are sometimes larger than necessary; yet the existing waste producers using the plant must pay the entire cost. Other times the community grows faster than expected and outgrows the capacity of the plant. In either case, the community must bear massive up-front costs for construction.

With advanced onsite wastewater treatment systems, the number of systems installed precisely matches the size of the community and can expand at whatever rate the community grows. Thus, advanced onsite wastewater treatment systems allow for a much closer fit between supply and demand than central systems.

Harold Ball of Orenco Systems, Inc. estimates that pressure sewers provide an average 30-50% savings compared to conventional sewering. Even in Montasanto, Washington, a high density area, he contends that the community saved 10% of conventional sewer costs by installing a Septic Tank Effluent Pump (STEP) system. At a total cost of tens of millions of dollars, this percentage becomes substantial.

A related issue is that conventional sewering can actually encourage development; the community has an incentive to add houses in order to recoup the cost of the sewer. At the Mayo Peninsula, Maryland, the community chose not to build conventional sewers specifically to avoid this problem. Land owners who wish to build are required to provide their own wastewater treatment.

One way to address the problem of "fitting" the sewer and the community is sound planning. Unfortunately, even communities that have developed extensive and well thought out land use plans have later encountered unexpected development when courts overrule building restrictions or when political climates change.

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[10] Stephen P. Dix, U.S. E.P.A. National Small Flows Clearinghouse, personal communication.

A second benefit of advanced onsite wastewater treatment systems is that they can be specialized to treat a variety of types of waste. Compared to centralized collection and treatment systems, which combine wastewater from many sources, advanced onsite wastewater treatment systems treat stronger waste (e.g. from restaurants) separately from other wastewater (e.g. from single family residences). In addition, the cost of treating this high strength waste is borne by its producer, rather than by all other homeowners and businesses in the area.

Third, a decentralized approach avoids the catastrophic situations that can occur with older centralized systems when combined sewer overflows exceed plant capacities (and are discharged directly, without treatment). A decentralized approach also avoids the discharge of large volumes of substandard effluent that can occur from sewers or centralized plants. Even highly skilled staff at central facilities cannot increase flow capacities or instantly repair failed systems. Although failure of onsite wastewater treatment systems will undoubtedly occur, a comprehensive maintenance and oversight program will prevent these failures from persisting for long periods of time, and the possibility of all systems failing at once is remote.[11, 12]

Fourth, these systems require a comprehensive management and oversight program to ensure their continued safe and effective performance. Studies of traditional septic systems less than six years old by Mike Hoover in North Carolina found failure rates of over 30%. Similar studies on systems with a single pump found failure rates over 60%. We have heard these figures cited repeatedly as demonstrating the need for a comprehensive management and oversight program for advanced onsite wastewater treatment system. An equally good case could be made that these data demonstrate the need for such management programs in communities with any type of onsite wastewater treatment systems. Certainly, 30% failure rates seem unacceptable.

Fifth, the necessary maintenance and oversight for advanced onsite wastewater treatment systems presents communities with a small business opportunity, as pointed out in a 1992 concept paper by the Association for the Preservation of Cape Cod (APCC). In central sewer systems, the cost of treating wastewater is tied up in concrete and pipes rather than in labor. The economic result is few long term small business opportunities after construction is completed and operations begin. In comparison, APCC points out, advanced onsite wastewater treatment systems provide numerous job opportunities from construction and installation to maintenance and monitoring throughout their lives. So, the total cost of advanced onsite wastewater treatment systems is generally less than the

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[11] To put the need for comprehensive operation and maintenance programs for onsite wastewater treatment systems in context, staff at the National Small Flows Clearinghouse and the New England Interstate Water Pollution Control Commission note that many cities are now regretting the lack of comprehensive maintenance programs for their sewer systems.

[12] Onsite wastewater treatment regulators repeatedly emphasize the necessity of comprehensive management programs.

total cost of conventional sewers, and more of the money spent for onsite wastewater treatment systems goes back into the local and regional communities and small businesses.

These and additional key features of advanced onsite wastewater treatment systems are summarized below:

- Allow higher housing densities and therefore greater flexibility in land use planning than traditional septic systems.[13]
- Allow for close fit between the strength of waste produced at a particular site and the level of treatment/technology required at the site. This contrasts the centralized approach, where high volumes of combined wastewater must be treated for pollutants that are discharged from a small number of sources.
- Allow for close fit between supply and demand.
- Allow close fit between level of waste treatment and the nature of the resource area in which the waste is produced.
- Create small business opportunities.
- Require oversight of operation and maintenance by a local board or regional agency, sometimes in cooperation with a 3rd party contractor.
- Requires education and certification programs for agencies and contractors.
- Periodic short-term failures will have only minor impacts on the total waste stream discharged to the environment.
- Failures are generally inexpensive to repair, at least from a community-wide perspective; systems are designed for easy maintenance.[14]
- Individuals must think about their wastewater and are therefore more likely to take responsibility for their behaviors in generating waste. This requires a comprehensive education effort; many homeowners do not care appropriately for conventional onsite wastewater treatment systems. The need for a sound education program can be extended to centralized systems, where homeowners need information about what they should and should not put down their drains.

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[13] Typically, rates at which effluent can flow from the leachfield into the soil increase compared to standard septic tank - leach field combinations and thereby enable a decrease in leach field size (see e.g. Loudon and Birnie. 1991).

[14] Based on information from National Small Flows Cleaninhouse; Richard Piluk (Anne Arundel County Health Department, MD); and other onsite wastewater treatment system engineers.

What Nitrogen Removal Onsite Wastewater Treatment Systems are Available?[15]

(Contributions from Stephen P. Dix - U.S. E.P.A. National Small Flows Clearinghouse, Richard J. Otis - Owen Ayres Associates, Dr. Joan Brooks - University of Maine.)

Background.

Nitrogen removal onsite wastewater treatment systems remove much of the nitrogen from wastewater and exist on the site that they service, with the effect of preventing nitrate from reaching the groundwater. There are three strategies which systems employ to achieve this goal: 1) Convert the nitrogen in wastewater into nitrogen gas (in this form it is innocuous since the Earth's atmosphere is 80% nitrogen). To accomplish this process (called nitrification/denitrification) requires passing the wastewater through a sequence of aerated and oxygen-lacking environments, in which the bacteria convert various forms of nitrogen to nitrogen gas. 2) Use micro-filters or media to attract and remove ionized nitrogenous waste. This entails cleaning, or regenerating, the filter media periodically, much as household water purifiers are cleaned. The resulting nitrogen-rich liquid could then be denitrified or recycled as fertilizer. 3) Intercept the nitrogen before it reaches the groundwater. This can mean spraying effluent on vegetated areas where plants can absorb the nitrogen through their roots; or segregating the bulk of nitrogen-rich waste (i.e., toilet wastes - "black water"), composting it, storing it for off-site treatment, and/or trucking it off-site.

In discussing "nitrogen removal", it is clearly important to consider not only how the nitrogen is removed from the wastewater but also where the nitrogen ultimately goes. Converting nitrate to nitrogen gas solves the groundwater and surface water problems. From a global perspective, this option is energy-inefficient because we expend considerable energy converting nitrogen gas to nitrate for agricultural fertilizers. Options that conserve energy and are therefore more efficient include recycling a nitrate-rich liquid or compost as fertilizer and spraying nitrogen-rich effluent on vegetated areas. These options reduce the need for producing fertilizers and therefore lead to a net reduction in energy spent. Carting the nitrogen-rich wastewater off-site to be dealt with elsewhere adds trucking costs and associated environmental impacts to whichever of the first two options follow the transportation. It also reinforces the prevalent perception that wastes can just disappear, which may not encourage environmentally responsible pollution prevention practices by individuals.

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[15] For design specifications and cost breakdowns for various advanced onsite systems, see WBNERR information sheets from the February, 1992 Nitrogen Removal Conference.

Composting Systems and Holding Tanks.

The impetus for separating black and gray water stems from the fact that black water contains 60-90% of the nitrogen in all domestic wastewater but accounts for less than 15% of the total daily flow if low volume toilets are used. Thus, it is possible to provide nitrogen removal facilities for a small portion of the waste stream and remove much of the total nitrogen.

Of these systems, some hold the black water for later collection (i.e., truck transport) and treatment. Others are constructed to compost or incinerate the solids.

The holding tank option postpones disposing of the waste and then requires moving it to another location. This means trucks, which are expensive, use energy, and produce air pollutants and noise pollution. This option must also include the construction of advanced treatment facilities to receive the waste. It may also mean transferring the problem (i.e., the nuisance of the treatment plant and truck traffic) to another neighborhood.

Of the alternative/composting toilets, some are "dry" and others incorporate flush, or "water carriage" toilets. All evaporate approximately 90% of the solid waste as carbon dioxide and water vapor and produce a compost or ash, which is commonly added to soils at the site. Incineration toilets evaporate and burn toilet wastes leaving an ash which is disposed with the household trash.

Composting systems generally do not treat the gray water (showers, bathroom sinks etceteras), which flows through a conventional septic tank and leach field. This system can also include a denitrification component like a sand filter or peat filter, and it may be possible to use a smaller septic tank and leach field than would otherwise be required.

Those composting systems which incorporate a flush toilet also produce a nitrate-rich liquid which could be disinfected and redistributed as agricultural fertilizer. Alternatively, it could be passed to a septic tank and leach field with a denitrifying filter.

These systems have a number of advantages. First, they are relatively simple in concept, operation, and design and therefore are unlikely to break down. Manufacturers contend that, contrary to popular belief, these systems require no particular attention by the homeowner. Second, in addition to treating the nitrogen, they greatly reduce the volume of solids which eventually require disposal. This is particularly important because septage treatment is costly. Although this is not directly connected to the nitrogen pollution problem, it is closely tied to the well understood problem of solid waste disposal, apparent to many communities whose landfills are fast reaching capacity. System manufacturers and persons with composting systems in their homes state that there are no odors associated with these systems.

Peat Filter

The peat bed filter is placed after the septic tank and functions as both filter and leach field. As wastewater moves through the peat, nitrogen is removed. Monitored systems in Maine suggest that removal rates can exceed 90% of the total nitrogen in the wastewater.[16] In addition, these systems seem to require extremely minimal maintenance. They include no moving parts (except where site constraints require using a pump), and subsidence has not been a problem with systems that have been in the ground for up to fourteen years. Because the peat bed remains exposed at the surface, it is necessary to protect it from vehicle traffic.

It seems unlikely that nitrogen removal is accomplished through the classical nitrification-denitrification pathway because the bacteria responsible for these processes are inactive over the pH range typical of this peat. In addition, aerobic conditions exist throughout the peat filter. Microscopic fungi present in large numbers in the system are capable of utilizing all forms of nitrogen present in septic tank effluent. In addition, studies of the relative activity of fungi and bacteria indicate that fungi account for the majority of metabolic activity within the peat. The inference is that the microscopic fungi are probably responsible for the nitrogen transformations within the peat bed.

A related concern is the excavation of peat, an essentially non-renewable resource, although system advocates report that the supply of peat needed for such systems is a small fraction of the total supply available. They also note that mined peat bogs can be reclaimed as other types of wetland habitat.

Dr. Joan Brooks emphasizes the need for following design specifications, including the type of peat used, to achieve expected results.

Recirculating Sand Filters and Synthetic Media Filters

The basic components of these systems include a "recirculation tank" containing a pump and a sand filter, which is placed between the septic tank and the leach field. These systems pass the septic tank effluent repeatedly by a series of filters made of sand or alternative material (e.g. pea gravel, bottom ash, mine slag, synthetic media). This process serves to aerate the effluent, which leads ammonium to be converted to nitrate. This liquid is then passed back into the anaerobic environment of the recirculation tank, where most of the nitrate is converted to nitrogen gas, which escapes to the atmosphere.

These systems are well understood and generally accepted. Nitrogen removal rates vary from 60% to over 90% depending upon the particular system. A number of variations on the general theme exist. For example, some systems incorporate a tank that adds carbon to the system. Others incorporate an anaerobic filter. These frequently increase the rate of nitrogen removal; they also represent added costs and added components to maintain.

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[16] Based on research by Dr. Joan Brooks, University of Maine, Orono.

In addition to removing nitrogen, these filters have the advantage of being relatively stable and of capturing solids that are carried out of the septic tank. This both reduces the strength of the waste, prolongs the life of the leach field, and reduces the necessary size of the leach field. Replacing the upper portion of the sand or alternate substance in the filter is generally easy and inexpensive.

RUCK System.

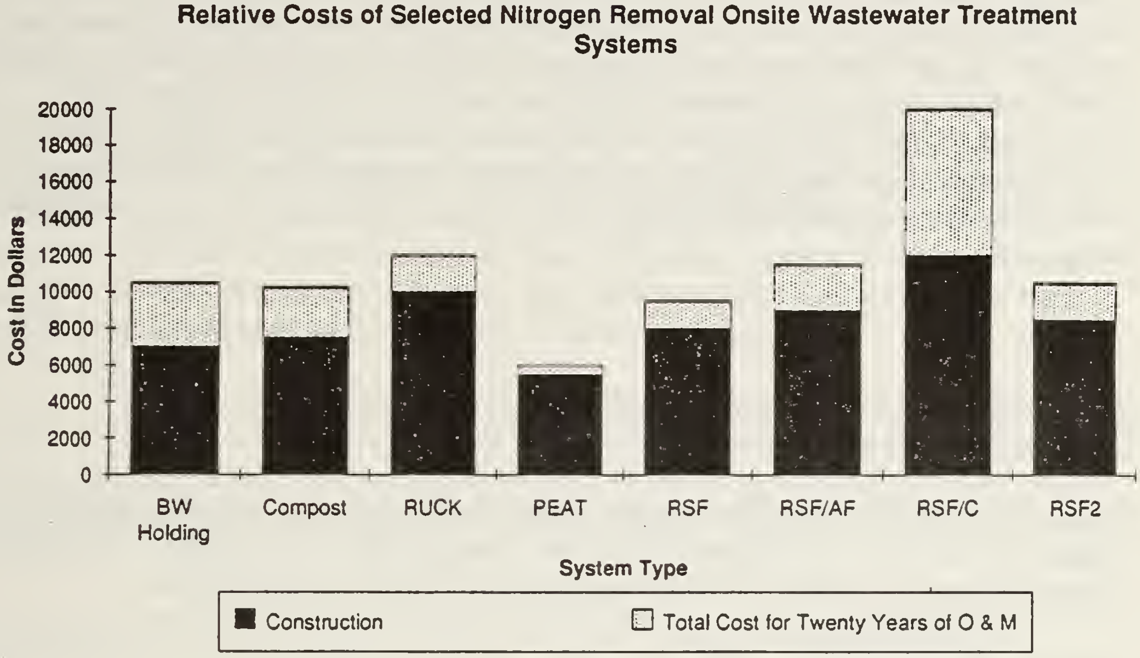
Like sand filters, the RUCK system relies on the biological activity of bacteria to convert ammonium first to nitrate and then to nitrogen gas. The RUCK system incorporates two septic tanks, one for gray water and the other for black water. The black water is aerated using a special filter consisting of layers of sand over rock with fabric between the sand and rock layers. The nitrified black water is subsequently mixed with the gray water in an anaerobic environment. At this stage, the gray water serves as a carbon (energy) source for bacteria which convert nitrate to nitrogen gas. The combined effluent then is discharged to a leach field.

Physical-Chemical Processes.

Systems that incorporate micropore filters or materials that absorb nitrate or ammonium ions (charged molecules) show considerable promise. They are much less common than the systems described above and require the simultaneous emergence of a technical support industry to make them feasible. Use of this technology will require the development of filters that resist biological clogging. In addition, services to regenerate the media will need to be made available. Although this requirement presents a technological and logistical challenge, it also represents a small business opportunity.

Costs and Nitrogen Removal Efficiencies.

Costs of advanced onsite wastewater treatment systems range from perhaps $4,000 to over $15,000 depending upon whether existing components can be incorporated into a retrofit and upon the quality of effluent desired. As discussed above, nitrogen removal efficiencies range from 40% to over 90%.



Costs of nitrogen removal onsite wastewater treatment systems vary. Costs also vary regionally and will probably decrease as technologies become more widely used. These numbers provide rough estimates of relative costs.[17]

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[17] Information from Stephen P. Dix, US EPA National Small Flows Clearinghouse. BW = Black Water, RSF = Recirculating Sand Filter, RSF/AF = with Anaerobic Filter, RSF/C = with Carbon Source, RSF2 = with Rock Storage Filter.

III - REGULATORY AND SOCIAL APPROACHES TO ADVANCED ONSITE SYSTEMS

One of the primary goals of the conference was to enable states to share information about what programs exist to meet the challenges that advanced onsite wastewater treatment systems present. To use these systems, states need reliable technology evaluation information and sound management and oversight programs. In addition, the advent of nitrogen-removal onsite wastewater treatment systems presents many states with implications for changes in zoning and land use planning strategies. Although we organized the conference agenda by state, we decided that it would be easier for readers to make useful comparisons by organizing the information according to particularly relevant and widely asked questions. Below we present some examples of the degrees to which different states have adopted advanced onsite wastewater treatment systems as a viable technology and of the strategies these states have developed to meet the associated challenges.

Where Do States Stand on the Use of These Technologies?

(Contributions by state representatives, as listed in Appendix C.)

It depends on the system and on where you live. Technically, it is possible to find a system to suit almost any site conditions, given enough space. States differ in terms of which systems they permit and what conditions they place on these permits.

Evaluating Technologies

States have essentially taken one of two approaches to evaluating technologies: in-house evaluation by regulatory agency staff (e.g. Connecticut, Massachusetts) or establishing a technical review committee, comprised of technical professionals from a variety of social and economic sectors (e.g. Washington[18]).

Most state regulators agreed strongly on the need for greater regional cooperation in evaluating systems. Because the evaluation process can be time consuming, it is important for states to be able to share information rather than performing a full evaluation of each system in each state. Similarly, there have been calls for regional and perhaps national performance standards for advanced onsite wastewater treatment systems. Three regional agencies available to facilitate this kind of information exchange are the New England Interstate Water Pollution Control Commission, a loose affiliation of onsite regulatory agencies in the Southeast, and the Great Lakes Upper Mississippi River Basin Committee on Individual Sewage Disposal Systems. There has also been a Northwest regional meeting, but it has not occurred for about five years, due to the downturn in the economy. Organizers of that meeting feel that it has been very helpful in the past.

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[18] See "Procedure for the Review of Alternative Systems" available from the Washington State Department of Environmental Health Programs.

Permitted Technologies - a Partial Listing:

One striking aspect of comparing states' onsite wastewater treatment regulations is that the regulatory agencies differ considerably in terms of their placement within the bureaucracy. For example, Wisconsin's onsite wastewater treatment code falls under the Department of Industry, Labor, and Human Relations while many others fall under a Department of Health and Environment. Our example from California, Stinson Beach, has a water management district which receives its authority from a county water management agency. These differences in organization between regulatory agencies complicates the process of making comparisons. One useful measure of a state's position on advanced onsite wastewater treatment systems seemed to be the types of systems permitted, the numbers of each system used, and the relative ease of obtaining permits for them. As with much of this document, the information below in neither exact nor complete; it is intended as an accurate representation of presentations at the February, 1992 meeting.

In Florida, accepted alternative systems (distinct from "experimental systems"[19]) include aerobic systems, mounded systems, sand filters, and composters with gray water systems. To use any of these systems requires only that users obtain approval from the local health department.

In Maine, peat filters are considered standard, along with septic tank-leach field combinations.

In the state of Washington, a number of non-standard systems are considered alternative and are available for use at the discretion of the county. Because the State is continually reviewing new system types, the suite of alternatives is expanding. At present, alternative systems in Washington include recirculating sand filters, composting and incinerating toilets, alternative drain fields, and some additional systems for treating septic effluent prior to entering the leach field. These alternatives are used extensively; for example, *using conservative estimates, there are three-to-four thousand intermittent sand filters in the ground.*[20]

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[19] Generally regulatory agencies distinguish between standard, alternative, and experimental systems, and each state has its own list for each category. Alternative systems are generally well understood, although the ease of obtaining permission to use one varies between states. Experimental systems are not well understood, and regulatory agencies generally grant such systems at most temporary permits with monitoring requirements.

[20] Intermittent sand filters do not recirculate the wastewater back to the septic tank or holding tank. Instead, the wastewater is discharged, at intervals, to the top of the filter, and it then percolates down through the filter. At the bottom it is collected and discharged to a leaching area.

Washington's Technical Review Committee (TRC) is now trying to revise its sand filter guidelines and mound/pressure distribution guidelines. This is in accord with the TRC's general practice of revising their guidelines periodically. They are also exploring peat systems.

In the Stinson Beach Water Management District, California, roughly a third of the 665 homes utilize intermittent or recirculating sand filters. In addition, many homes utilize composters, mound systems, black-&-grey water systems, holding tanks, and pressure dose systems.

In Maryland, hundreds of recirculating sand filters are in use. At the Mayo peninsula, a community level treatment facility for septic tank effluent, served by small diameter sewers, is comprised of a recirculating sand filter, a gravel wetland, and a peat filter.

In Massachusetts, the RUCK system is permitted as an alternative, which requires approval from the local board of health as well as a variance from DEP. To apply for a variance costs $400, and DEP has sixty days to respond to applications.

Massachusetts also allows dry composting systems and is optimistic about their ability to grant speedy variances for sand filters, although the state does not yet have any in the ground.

Recently, under Massachusetts' experimental systems protocol, an Ekofinn-Bioclere unit, which uses a synthetic media filter, was installed under an experimental permit, was installed at a two-family residence in Yarmouth. For further information on Massachusetts, see appendices B and C.

Our inquiries to Pennsylvania along these lines met with the response that many different sorts of systems may receive approval, including constructed wetlands, evapotranspiration greenhouses, small flow spray irrigation, and composting systems. However, individual permits are closely tied to comprehensive sewage disposal plans. Whether or not a particular system receives approval depends upon the sewage disposal plan under which the application is submitted.

Additional states not represented at the conference but which have a history of important work with advanced onsite wastewater treatment systems include Oregon, North Carolina, and Minnesota.

Is There Much Research to Improve These Technologies and Develop New Ones?

Some but not enough. In many cases, regulatory agencies attempting to proceed with caution and protect the public health inadvertently construct barriers to innovation. Research to develop new products requires funds and the potential for profits. In a regulatory arena structured to preserve the status quo, incentives to find venture capital for new technologies are few. In addition, public and foundation funding sources for this type of research are scarce.

Taking a direct approach, Wisconsin funds an onsite wastewater treatment system research program from the general income tax rolls. The current four-year appropriation totals two hundred thousand dollars.

Dr. Kevin Sherman, from Florida's Department of Health and Rehabilitative Services, repeatedly emphasized the need to balance consumer protection with the possibility that there may be a better system - "a better mouse trap" - out there. In attempting to find this balance, Florida's experimental system protocol enables proponents of new systems to install between 25 and 100 systems on a temporary permit. The systems are tested for at least one year after the last one is installed, and the proponent must pay for the monitoring and testing. To achieve clarity for both the regulatory agency and the proponent, the two parties enter into a contract which states that the systems will be tested against specific claims of the proponent. If the test meets the standards claimed by the proponent, the system will be reclassified as an alternative, and the agency will repromulgate the code.

Florida's concern is reflected in the establishment in 1983 of a state research fund for onsite wastewater treatment. Supported by a dedicated $5.00 surcharge on each septic system construction permit issued, the fund has totaled approximately $300,000 per year. Up to now, this money has been used primarily for research on the environmental impacts of septic systems in high densities.

Indirect incentives for research on advanced systems stem from Florida's 1983 Water Quality Assurance Act. This legislation establishes mandatory repair permits which require that old systems meet current code. This does not address the nutrient loading problem since standard systems in Florida do little to remove nitrogen. However, a modified version of this code could provide for the upgrading of existing systems to include nitrogen removal capabilities. This, in turn, would provide incentives for the development and production of advanced technologies.

In 1972, the Stinson Beach Water Quality Management District, California, was ordered to cease installing any new septic systems and to remove existing ones by 1977. This set an important precedent for setting a mandated target date for dealing with existing systems. In addition to confronting the problem of existing systems, this kind of rule creates a market - and therefore an incentive for innovation and the development of new systems.

Craven County, North Carolina, also supports a research program. After the county commissioners decided that it was necessary to develop the land and economy of the region, a program was established to draw $250,000 per year from the general revenues for this onsite wastewater treatment research program.

Why Don't States Permit More of These Technologies?

Aside from evaluating the technologies, which many states consider the lesser challenge, the main hurdles that regulatory agencies face are ensuring adequate maintenance, oversight, and management of the systems, and funding research on innovative systems. In some cases, regulatory agencies are further burdened with the legacy of wastewater treatment regulations being used for land use management, in the absence of land use regulations based on comprehensive planning or resource area concepts.

Are There Any Good Models for Management and Oversight?

(Contributions by state representatives, as listed in Appendix C.)

One of the main concerns raised repeatedly in discussions on onsite wastewater treatment options is the problem of ensuring adequate management and oversight. Traditionally, homeowners, as a group, have failed adequately to perform basic maintenance such as pumping septic tanks or adding clorox to disinfection units. Even hydraulic failure, which sometimes leads to ponding[21] of wastewater above ground, can go unreported for long periods of time. Thus, regulatory agencies express serious concern about the installation of large numbers systems that are mechanically more complex (and therefore more prone to failure) than passive septic tank - leach field combinations. Clearly, communities with an interest in utilizing these technologies have an interest in looking to existing management and oversight strategies for onsite wastewater treatment systems in developing appropriate management plans of their own. Scattered examples of effective management strategies exist at both the state and county level from around the country, and we present key elements of those plans below.

Operation & Maintenance: How Much & How Often?

While there appears to be general agreement about the need for adequate assurance of sound operation and maintenance procedures, regions differ in the frequency and rigor of O & M actually required, and in the mechanisms used to ensure that it occurs.

In Florida, in areas zoned for industry, the state requires an annual operating permit for onsite wastewater treatment systems, with sampling at the owner's expense. In addition, Florida requires annual operating permits for aerobic plants, which are subject to unannounced, random inspections.

In Washington, a proposed change to the state regulations, which would bind on all local health departments, would require ongoing operation and maintenance, at least in designated environmentally sensitive areas. It would also require that all users be notified once every three years that they are on onsite wastewater treatment systems and how to take care of them.

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[21] Ponding means the formation of puddles of wastewater above the ground.

Interestingly, some Washington realtors have expressed a desire for mandatory operation and maintenance throughout the state; other concerned parties, including some public health officials, share this desire but do not believe it is practical.

The Washington State Technical Review Committee guidelines for alternative systems include special operation and maintenance guidelines for these systems, although these may not yet be sufficiently implemented. The degree and type of monitoring will also vary between geographic locations, depending upon particular features and ecological sensitivity. At this point, it is not incumbent upon counties to use the guidelines.

Taking an example from the regional level in Washington, Thurston County has been issuing operation permits for **all** onsite wastewater treatment systems since September, 1990. The requirements for these permits rest in the county health regulations. If all goes as planned, this method of oversight will give the county a way of knowing when systems are failing and in what ways.

Because the county does not have the technical or legal resources to implement this program all at once, Thurston County has chosen a *phased approach*, with the objective of eventually having all systems within the county included in the system. The operation permit requirement takes effect on a piece of property when it is sold, when a new structure is built, when an old structure is remodeled, or when a system fails. Since 1990, 6000 systems, of the 40,000 in the county, have been brought into this program.

Thurston County's citizen advisory board played an important role in implementing this permitting system. Initially, all members of the board's subcommittee objected to the use of operation permits. However, they eventually agreed that they wanted a mechanism to inventory onsite wastewater treatment systems, and to perform routine inspections and monitoring. After agreeing upon these goals, the subcommittee recognized the utility of the operation permit approach.

To fund the operation permit program there is a permit fee. This is assessed once every four years, although renewal for some systems may be more frequent. At the same time, people also pay approximately a one-hour inspection fee and a half-hour administration fee. There is currently an additional fee of $2.50 per month for the purpose of evaluating the effects of systems on ground and surface water quality. This fee is now being reconsidered The total cost for the program (which provides oversight, not actual repair services) is perhaps $27.00 per household per year.

If, as expected, the system is further privatized, the cost decrease to $12.00 or $17.00 per year. There is additional speculation about the possibility of adding a monthly fee to build up a reserve account to finance a low interest revolving loan fund. At present, the county (and approximately five other counties in the state) does have a loan program, financed by the state and administered through the counties. The state originally secured the money from the federal government; recently, the funds were made available through the counties for onsite wastewater treatment system repairs. A difficulty with the loan program in Thurston County is that only those with an appropriate credit history receive them, so the most needy may not benefit. Of other counties participating in this program, some have less restrictive requirements, 0% interest, or guaranteed loans.[22]

Although this program is well developed compared to Massachusetts' permit system for advanced onsite wastewater treatment systems, Washington regulatory officials still view the assurance of ongoing operation and maintenance as one of their system's weak points.

The Stinson Beach Water Management District, in California, issues annual, biannual, or quarterly operating permits for all onsite wastewater treatment systems within the district. Generally, all new systems receive an annual operating permit, with the possibility of inspection on a quarterly basis. As the agency becomes satisfied that the system is operating properly, the permit may be renewed on a biennial basis.

Permits are renewed only if a system is operating properly; the permit for a system that has failed is issued only after the system has been repaired. The district also has strong regulatory and abatement powers, one of the most drastic being the ability to shut off the resident's potable water supply if he/she is not treating the wastewater according to regulations. To date, the agency has never exercised this power.

To ensure that maintenance will be done responsibly and that parts will perform reliably, the Stinson Beach Water Management District requires that homeowners use licensed contractors. The agency feels that this arrangement has worked out extremely well.

The Stinson Beach Water Management District's power to regulate onsite wastewater treatment systems is delegated by the regional water quality control board, which receives its authority under the California Water Code. Similarly, its power to regulate drinking water is delegated by the state department of health. If these delegating agencies are dissatisfied with the district's performance of these functions, they can fine the water management district, issue orders to cease building or remodeling homes, and issue boards of health to inspect homes and evict occupants who are not in compliance.

In Wisconsin, onsite wastewater treatment systems in need of upgrade are identified when plumbers called to the site notice ponding, during real estate transfers, or during inspections. Inspections are conducted by short-term county employees who receive training. While this program is perhaps not as comprehensive as some, it is a good example of a state and its counties using the available resources to begin addressing an important need. A key component of this program is the availability of income-sensitive grants through the Wisconsin Fund to supplement the cost of upgrades.

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[22] Further information about costs and finance programs appears in the section: "How Will We Pay for Advanced Onsite Systems?"

Among wastewater treatment professionals, there is some disagreement about how much oversight different types of onsite wastewater treatment systems need. For example, some science/management agencies feel that peat filters, which are passive systems, require less than annual inspections. The recognition that technologies of varying complexity require different levels of maintenance (by contractors) and oversight (by regulatory agencies) has led North Carolina to develop a matrix to match individual technology types with management and maintenance requirements (see Appendix G).

Certification: Who Does the Work?

The State of Florida certifies all persons who construct, pump out, repair, or replace systems. By regulating the contractors, the state agency tries to ensure that repairs are done properly. Dr. Kevin Sherman, at the Department of Health and Rehabilitative Services, contends that if unregulated persons perform repairs, licensed contractors hear about it and report it to the state to protect their own business interests.

The state of Washington leaves operation and maintenance responsibilities to local jurisdictions. Certification programs exist for system design, installation, and pumping, but not specifically for operation and maintenance (i.e., trouble shooting, replacing failed parts). Some engineers who design systems may wish to take on these responsibilities, but the skills required for operation & maintenance differ from skills needed for design, hence the perceived need for a separate certification category. However, this proposal has not been well received by counties, who do not want the added burden of yet another certification program. Thurston County may be the first to adopt this new class of certification.

At present, in Washington, county health staff make the inspection when systems are due for renewal. They may or may not require pumping. The idea is to put that whole process in the private sector, while making periodic spot checks. Public officials would then become information gatherers, analyzers, and data managers, to answer existing questions and change regulations as information analysis points to needs.

Maine's soil evaluator certification program provides another good example of using a training and certification program to improve the regulation of onsite wastewater treatment systems in a state. Rather than using the traditional perc test to determine which systems are appropriate for which sites, Maine trains site evaluators to base decisions on detailed examinations of soil profiles.

In the Stinson Beach County Water Management District, CA, the district's staff perform inspections and issue permits. Projects under way in other parts of California have begun to use the private sector to perform tasks like inspections.

Although no official certification program or requirements exist in Stinson Beach, this issue has begun to emerge. In the past, staff have worked closely with a consultant who holds relevant certifications, and some have proceeded to acquire certification in fields such as civil engineering. The agency anticipates that minimum requirements will soon resemble those for septic system designers. Discussions in California about long term programs include the possibility of a separate training and certification program for onsite wastewater treatment inspection and maintenance.

If regions desire training and certification programs, they should plan these programs as part of a phased approach for using and managing advanced and conventional onsite wastewater treatment systems.

How Will We Pay for Advanced Onsite Systems?

(Written in collaboration with Scott Horsley of Horsley, Witten, & Hegemann; Peggy Sloan of the Association for the Preservation of Cape Cod; Steve Dix of the National Small Flows Clearinghouse; and Dr. Yoshiaki Kaoru - Center for Marine Policy at the Woods Hole Oceanographic Institution.)

How Do We Pay?

Mechanisms are available to channel money from the source to the advanced onsite system arena. A number of traditional sources merit consideration, including permits, fines, and taxes.

Grants

From EPA, the State, or Housing and Urban Development's Community Block Grant (CBG) Program. In the past, a common source was EPA's construction grants program. Normally this was used for municipal sewers but also for innovative alternative solutions. Those dollars have disappeared. CBG dollars are still used to capitalize revolving loan programs that fund onsite system repairs. The Farmers' Home Administration Rural Development Authority is another potential source of funding for advanced onsite wastewater treatment programs.

Banks

Mortgages to buy houses also buy septic systems. Equity lines or mortgages of $10,000 over thirty years at 8% or 9% can become affordable.

Fines and penalties:

For example, through groundwater discharge regulations, it is possible to fine violators.

Access, Permit, and Service Fees:

A surcharge on water bills, for example, could generate funds for research to develop efficient, effective onsite wastewater treatment systems. This approach utilizes a holistic approach to water management and recognizes the links between drinking water supplies and wastewater treatment. It also shares characteristics with approaches taken by gas companies in diverting money from user fees to develop efficient technologies. Fees can also be associated with services such as maintenance programs.

Impact Fees:

These generally consist of a one time lump-sum payment, paid by a developer to cover the estimated cost of the development to the community. This could include the cost of remediating nutrient loading problems. Impact fees have the advantage that the user of the resource pay for its protection. However, it is expensive to implement since public staff time is required to estimate the impact fee for each site. In addition, the revenue source is not particularly stable since it varies with the level of development activity in a region.

Taxes:

Governments have gone to this source time and time again for specific projects. These can include property taxes, excise taxes, income taxes, and real estate transfer taxes. Similarly, tax credits can be an important means of funding advanced onsite wastewater treatment systems.

Clearly, we need some criteria for selecting funding sources that make the most sense for Massachusetts and for local municipalities. Several good criteria include:

(1) equity - what funding mechanisms are most equitable?
(2) efficiency - what funding mechanisms avoid using much of the money in getting it to the intended destination?
(3) public and political acceptability - what funding mechanisms are most likely to gain support in town meeting or in committees, at the state level?
(4) long term viability/constancy - what funding mechanisms will have stability in the long term? The Nantucket property transfer tax may be good for buying land but less good if we have ongoing expenditures like operation and maintenance of advanced onsite wastewater treatment systems because when the real estate market is slow the tax won't generate much money.

Who Will Pay?

The question of who will pay is addressed, among other places, when a town or region engages in the facility planning process. Traditionally, this process has focused on central sewering for wastewater treatment, and much of the cost was carried by EPA's construction grants program. With that program no longer extant, communities need to look more broadly at what facilities and funding mechanisms are most appropriate. This also involves thinking about how wastewater management districts or other regional agencies might be established or empowered to take on oversight and finance management responsibilities. An equally important question that arises is what roles the private sector will play as advanced onsite wastewater treatment systems proliferate.

There are three obvious possible answers to the question of who pays: Everyone, just people causing the problem (if we can identify them), and people who use the resource. Should everyone pay? Perhaps all residents of Cape Cod should pay. This eliminates the need for identifying specific populations or resource areas. It could even be argued that Massachusetts is a small enough land area, whose overall economy is closely tied to the coast, that it is the responsibility of everyone in the state to contribute to the protection of coastal resources.

The second category, just people who cause the problem, presents some subtle facets. Traditionally, we have thought of polluters as people who do obvious and hazardous things. The origin of this view is well illustrated by considering poor practices by small business and industry that have resulted in the closure of public supply wells. Here, we face a less overt situation. In addition to the substantial numbers of people who have failed to upgrade their sub-standard onsite wastewater treatment systems, many well-meaning citizens have installed Title 5 systems and view them as a solution. All these homes contribute to the degradation of Massachusetts' coastal waters. In addition, it is difficult to know just who resides in recharge areas because recharge areas often cannot be defined precisely.

A region could, for example, establish a tax based on the environmental impacts of particular onsite wastewater treatment technologies. The proceeds from this tax could then be directed to a fund used to finance loans for upgrading onsite wastewater treatment systems.

Third, looking at only people who use the resource, we encounter shellfishers, pleasure boaters, sightseers ("bay-viewers"), and swimmers. Should they pay? Perhaps revenue could be generated through the sale of recreational shellfish permits or recreational boating permits.

In an analogous situation, if our goal is to pay for protecting drinking water, perhaps we should go to the users. Drinking water is much too inexpensive; the costs are not what they should be because all the costs are not incorporated into it. The same is probably true of coastal waters and other resources.

Important twists and difficult questions enter the question of who will pay. For example, in a recharge area where the water resource is impacted by septic tank effluent, how will we distinguish between existing and future development? We could, for example, require all new development to incorporate nitrogen-removal onsite wastewater treatment systems. Some proposals have gone so far as to suggest that new builders will also install such systems for a neighbor. In this case, the implicit judgement is that newcomers should bear a greater share of the cost of protecting the resource than past residents.

It may be that, to protect the resource, only some portion of the residences in a resource area require advanced onsite wastewater treatment systems. Which homes will they be? Will the entire community contribute to the added cost of those systems? If so, who will own the systems - the town, a wastewater management district, or the individual?

If systems are to be retrofitted over a period of time, should the entire community pay into a fund that is then used to retrofit a designated number of systems per year? If so, which individuals should receive new systems first?

Economically, it may make sense to have several residences on a single advanced wastewater treatment system. This situation could also arise where densities of existing homes do not allow for Title 5 systems on each lot. Here the financing again presents complex options and difficult choices. On whose land will the system reside? Will the other homes feeding into the system pay compensation to that home? Who will be accountable if the system fails?[23]

Money will be required not only to install the systems but also to maintain them and to replace failed systems. This is an area where the private sector could certainly have a role to play. Should all homeowners pay a monthly fee, they do to utility companies, with the costs of repairs being distributed among the community? Should individuals pay for their own repairs, providing incentives for people to take good care of their wastewater treatment systems? What is the most appropriate finance distribution and management mechanism for onsite wastewater treatment system maintenance in each community?

In Massachusetts, the Department of Environmental Protection is now requiring that all cesspools be replaced by Title 5 systems. This is a tremendous opportunity to cut costs in the long run and upgrade to nitrogen-removal systems from the start.

In this case, how should costs be distributed? Many members of the community may have already paid to upgrade from cesspools to Title 5 systems; such individuals would rightfully object to subsidizing neighbors, who have been less responsible than themselves. Perhaps it would be useful to calculate the *additional* cost of the nitrogen-removal components and pay only this cost from community-administered funds. How should this situation be resolved?

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[23] For further discussion of the associated land use questions, see section: "How Will the Use of these System Affect Land Use in Massachusetts?"

Selected Case Studies:

In exploring revenue generating options for Massachusetts, it is instructive to consider some case studies.[24]

- Spokane Washington created a special financing area for wellhead protection. In this case, people contributing to the pollution paid the price of protecting the resource. This entailed delineating the recharge area, something which is not always easy to do. In that area, Spokane instituted a sales tax and a real estate transfer tax. The revenue goes to sewer construction. In addition, there will be the more traditional access fees to tie into sewer and unit charges based on how much sewage the individual home generates.

- A wellhead protection program in Iowa, which has a large agricultural base, attached a fee to the sale of fertilizers. This fee is directed towards water quality protection. Again, people contributing to at least one aspect of water pollution (people using fertilizers) are paying for protecting the resource.

- In Florida, service fees and permit fees for onsite wastewater treatment systems raised $6,000,000 per year at the county level to pay for costs incurred in the onsite wastewater treatment program. A similar amount of funding for the program comes from property tax revenues.

- The state of Wisconsin uses state income tax rolls to finance a dedicated fund of approximately three million dollars per year for upgrading sub-standard onsite wastewater treatment systems. This fund is administered as income-sensitive grants.

- Santa Clara Valley, California, instituted unit charges and property taxes to fund a variety of activities.

- Currently, Senate Bill 895, legislation pending in Massachusetts, would empower boards of health to attach betterment charges to properties with failing systems and allow the property owners to put in repaired systems.[25] The costs would be built into the betterment charges over time. This would give Massachusetts' boards of health more power to get things done with property owners who say they can't afford it the cost.

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[24] Technical assistance documents are available from EPA, including one that addresses some of these case studies.

[25] Editor's note: "bettering" failed systems does not necessarily mean installing nitrogen removal systems since Title 5 systems are not required to remove nitrogen. Towns might be able to require that "betterment" include installing systems with nitrogen removal capabilities.

- In Florida, 1983 legislation established a $5.00 surcharge on each septic system construction permit issued. The fee goes to a dedicated research fund, currently used primarily to investigate the environmental impacts of onsite wastewater treatment systems in high densities.

- A second financing program in Florida relies on fines of up to $500.00 per day for sub-standard or failed onsite wastewater treatment systems. Identifying these systems can be difficult under certain climatic and environmental conditions.

- The Stinson Beach Water Management District in California charges users a monthly service fee of approximately $12.00 per household. The true cost of the program is about $21.00 per household, and the difference is acquired through a portion of the county property taxes for each home in the district. For this small fee, the district is able to provide users with extensive water quality monitoring (groundwater and surface water in three estuaries every two weeks) to ensure all members of the community that their water resources are protected. The water management district staff also conduct periodic inspections of all the onsite wastewater treatment systems in the district and administer a permitting program.

- Thurston County, Washington, finances its permit and inspection programs with associated fees that are assessed once every four years. People also pay a small administration fee. There is currently an additional fee of $2.50 per month for the purpose of evaluating the effects of systems on ground and surface water quality. This fee is now being reconsidered The total cost for the program (which provides oversight, not actual repair services) is perhaps $27.00 per household per year.

  There is additional speculation about adding a monthly fee to finance a reserve fund for a low interest revolving loans. At present, the county (and approximately five other counties in the state) does have a loan program, financed by the state and administered through the counties. The state originally secured the money from the federal government; recently, the funds have been made available through the counties for onsite wastewater treatment system repairs. A difficulty with the loan program in Thurston County is that only those with an appropriate credit history receive them, so the most needy may not benefit. Of other counties participating in this program, some have less restrictive requirements, 0% interest, or guaranteed loans.

- Some communities (e.g., Duxbury and Chatham, MA), through local Board of Health regulations, issue their own permits in addition to disposal works construction permits. There are fines associated with these permits, and such fines could be used to finance advanced onsite programs.

The Nantucket land bank bill generated $50,000 or $60,000 per week for the acquisition of open space during the housing boom. Money generated in similar ways could be used for alternative wastewater treatment with minor changes to the legislation.

Can We Measure the Value of Natural Resources?

(Contribution by Dr. Yoshiaki Kaoru - Center for Marine Policy, Woods Hole Oceanographic Institution.)

Strong links join natural resource protection and short term economic costs, as illustrated by peoples' concern about the costs of advanced onsite wastewater treatment systems. In this framework, it is worth noting that we can, at least to a degree, measure the benefits society gains from natural resources and express these benefits in economic terms.

In establishing the economic value of natural resources, we frequently concentrate on the value of commodities produced within the resource (e.g., sales of shellfish harvested in a bay) and the moneys spent by persons using the resource (e.g., sales of hotel rooms and restaurants). Yet society clearly places a value on natural resources, independent of how much we use them, and we should not ignore this important component of natural resource valuation. To establish these so-called existence values, resource economists use a sophisticated survey approach, illustrated here by two projects carried out on Martha's Vineyard.

In one study, researchers asked the following question of property owners: How much are you willing to pay for improving the water quality in three particular coastal ponds which were closed for shell fishing for extensive periods of time in summer, enough to have them open for shell fishing year-round? The average response was $131 per year, with one respondent willing to pay $2,000 per year. Of this average $131, respondents assigned their willingness to pay $77 per year simply for the existence of the resource, with no respect to their intent to see it or use it at any time in the future.

The second project on Martha's Vineyard involved a survey to find out how much people would be willing to pay to use the beach, above the actual cost to them. Two groups were surveyed - summer and year round residents and short-term tourists.

The average visitor to Martha's Vineyard stays eight days and spends a total of $1,200 during the peak summer season. On average, respondents were willing to pay $744 more than that. Residents were willing to pay between $2 and $20 per trip to the beach.

These figures typically do not get accounted for in valuing the beach, yet they should be taken into account. They indicate that people are in fact willing to pay to protect natural resources, and this should include willingness to pay for advanced onsite wastewater treatment systems, *providing people connect using advanced onsite wastewater treatment systems with protecting a resource that they value.*

How Will the Use of these Systems Affect Land Use in Massachusetts?

(Written in collaboration with Margo Fenn, Chief Planner at the Cape Cod Commission and John Witten of Horsley, Witten, and Hegemann)

The Dilemma of Growth Management - How NOT to Do It.

Planners and local officials have long been concerned that if denitrification technology for onsite wastewater treatment systems becomes widely accepted and used, this may allow for greater overall development. Lands that are not currently developable because of soil limitations or other natural resource constraints could become buildable; higher densities may also be possible through redevelopment of existing neighborhoods. Because advanced technology for onsite wastewater treatment systems may soon be feasible, land use experts are stressing that nitrogen loading is not and should not be the sole basis for determining desirable land use patterns. Towns must undertake a comprehensive look at their existing resources and future needs, and make informed choices about where and how to grow.

The future development implications of denitrifying systems will depend, in large part, on the land use planning efforts of Massachusetts towns and regions. In the past many communities have relied on lot size requirements in their zoning regulations. This has certainly been the case on Cape Cod, where a one acre lot minimum has generally been accepted as the minimum size needed for a single family home in order to protect groundwater quality. Unfortunately, this requirement has led to a low-density, suburban-style development pattern that has undermined the Cape's traditional settlement patterns and blurred the boundaries between village centers and rural areas.

According to John Witten, this is an excellent illustration of the wrong way to manage growth: at the level of the septic tank. Managing growth at this micro level does not lead to communities that meet the residents' needs or expectations. Rather, growth must be managed at a larger scale, through a logical, sensible comprehensive planning process.

Ways To Manage Growth - Possible Solutions.

Mr. Witten sited the specific example of Buttermilk Bay, a small embayment within Buzzards Bay, to illustrate this type of logical, comprehensive planning. The project first conducted a contributing area analysis, delineating the area they were trying to protect. Their nitrogen loading calculations showed the current load to be approximately 91,000 lb N/yr and the load at buildout to be approximately 126,000 lb/yr. Five different buildout scenarios all exceeded the critical loading limit for the bay. The project found that greater than 66% of the loading was from septic systems. The end result was the adoption of new zoning regulations by the three towns in the Buttermilk Bay recharge area to limit the nitrogen loading at buildout to within the critical loading limit.

In this case, the planning process went forward with the specific intent of managing nitrogen inputs to the bay. However, the process is good enough and logical enough to manage housing density even if no nitrogen is involved, and if there were no phosphorous, no surface nor drinking water quality issues at all.

A key point here is that local government has the power to manage growth for a quality environment. The process outlined by Mr. Witten follows these guidelines:

1st - determine what we are trying to protect - which areas.
2nd - perform a developable lot analysis.
3rd - do the necessary loading calculations
4th - develop a plan for protecting or restoring the resource.

Regulatory approaches to managing growth include creating overlay districts (e.g. zoning for water protection/wellhead protection). Similarly, one could create a critical district to manage septic systems. Again, the key aspect is delineating the area you want to protect. Once you know what you're trying to protect, change the rules accordingly.

An example of a legislative approach is found in chapter 40A of Massachusetts general law, which gives planning boards and zoning boards great power to require that decisions and actions be in harmony with the purpose and intent of the zoning bylaw/ordinance (e.g. must protect water quality). Clustering provides a very important tool to planning boards. It allows for shorter lengths of roads, buffer strips, and open space. All communities in Massachusetts should adopt this tool, which provides a large number of flexible opportunities.

"It's about time, in this state at least," stated Witten, "that we take the lead in developing systems in some sort of regulatory format that would allow flexibility. The burden right now is strictly on local government."

Cape Cod - Grappling With the Promise of Advanced Onsite Systems.

The example of Cape Cod may be useful to other communities grappling with how to manage growth. In developing a Regional Policy Plan for Cape Cod, the Cape Cod Commission put strong emphasis on concentrating growth in designated growth centers to reinforce the village-style development pattern of the Cape and preserve open space and environmental resources. However, village-style densities cannot generally be supported by conventional onsite septic systems because of nitrogen loading problems. Public sewering on the Cape is extremely limited and it is unlikely that there will be any major expansions in the foreseeable future due to the expense involved, the lack of state and federal funds, and the difficulty of disposing of the treated effluent. *Thus, the use of alternate onsite wastewater treatment systems that reduce nitrogen provides a very important opportunity for towns to effectively shape their growth patterns. Using denitrifying systems, towns could designate appropriate areas for higher density development while preserving surrounding open space with more restrictive zoning.*

Similarly, Wisconsin sees advanced onsite wastewater treatment systems as a means to utilize poor soils for housing, thereby preserving good soils for farmland.

The key to controlling growth without conventional wastewater constraints is a strong land use planning and regulatory program. Communities need to develop a vision of what they want to be and how they wish to grow. Nitrogen loading is only one of a myriad of factors that need to be considered in planning for land use. Of equal importance are other natural resource constraints (e.g. wetlands, plant and wildlife habitat, flood hazard areas), as well as factors such as availability of public infrastructure, the need for affordable housing, the location of economic centers, and historic land use and settlement patterns. An effective planning program needs to examine all of these factors in determining appropriate locations and densities for development. A build-out analysis should be prepared to evaluate impacts to natural resources and community character under different development schemes. Then it is possible to establish a land use plan designed to protect the whole range of community values, not just water quality.

Once a community has developed a comprehensive plan for how it wishes to grow, there are a variety of regulatory tools available to control the location and density of both new development and redevelopment. These types of regulations may be especially important in controlling redevelopment in coastal watershed areas. The use of denitrifying septic systems in these areas offers the potential to improve existing problems of excessive nutrient loading in adjacent coastal waters, while still allowing for a reasonable measure of growth. Coupled with appropriate zoning measures, nitrogen loading regulations can control not only the impacts of new development, but the effects of seasonal conversions and expansions of existing uses as well.

It is important to remain aware that, while nitrogen-removal onsite wastewater treatment systems offer the ability to overcome a major stumbling block to directing new development towards existing centers of growth, additional challenges also need to be met. There are, for example, important financial issues related to property development rights. A basic idea is the ability for developers in growth centers to buy development rights from people owning land in more rural areas. In theory, this would allow for the preservation of greenways (large tracts of open space). One of the remaining challenges to encouraging the transfer of development rights from rural areas to growth centers is developing ways to compensate for differences in the market value of rural vs. urban lots. If homes in urban centers sell for less than homes in rural areas, then urban developers will be unlikely to pay fair market value for development rights to rural land owners.

The key point is that nitrogen loading is not and should not be the sole basis for determining desirable land use patterns. Local officials must manage the use of denitrification technologies within the context of a thorough local planning program. The use of denitrifying septic systems can provide communities with more flexibility in planning for future growth. This should strengthen the effectiveness of local land use controls.

How Do Communities Use these Systems to Protect Their Environment and Character?

(Contributions from Donna Briesemeister - Washington Island Wisconsin, David Dow - North Gloucester Villages Association, David Lenning - Thurston County Department of Environment and Health.)

Much of the concern about management of advanced onsite wastewater treatment systems rests on the concern that homeowners, and business owners, do not want to think about, and cannot be trusted to be responsible for, their wastewater treatment systems. This concern stems, in large part, from a history of communities ignoring the potential problems stemming from many failed systems, and from homeowners' refusals to perform routine maintenance such as septic tank pumping on a regular basis. Communities that can organize themselves and show regulatory agencies reasons to trust them with managing their wastewater treatment will be taking a significant step forwards. Below, three examples are described.

One particularly inspiring example is ***Washington Island, Wisconsin***. This community (700 persons year-round, 2,000 persons summer) has taken the initiative to explore wastewater treatment options, reject standard paradigms of centralized facilities, seek out advanced onsite system engineers, and convince state regulatory agencies and universities to work with the community to implement a pilot project using advanced onsite wastewater treatment systems to meet their wastewater treatment needs.

A second example comes from ***Gloucester, Massachusetts***. Here, the city is under a court order to improve a currently unacceptable situation in which many houses have cesspools, which do not meet current code requirements. The mandate gives the city one year to look at alternatives to sewering, and the North Gloucester Villages Association has taken on this project. This community is looking particularly closely at composting toilets in combination with sand filters to treat the black water. However, the project coordinators emphasize that the community is interested in looking at using an array of systems to meet the specific needs of locations within the community and preferences of individual home owners.

Ultimately, decisions about regulations in ***Thurston County, Washington*** will be made by the county advisory committee, which is involved with all issues related to onsite wastewater treatment systems. Although not bound by the committee's recommendations, the county (which receives its authority from state enabling legislation) plans to forward their recommendations to the local board of health even if regulatory officials disagree. The county convened the advisory committee (17 members), which includes representatives of all major groups affected by onsite wastewater treatment systems. This includes mobile home park and owners, shell fishermen, building industry representatives, watershed planning committee members, realtors, general citizen representatives, manager of small drinking water systems and on site systems, and lending agencies.

The committee structure and power has evolved largely due to the conviction of David Lenning that the regulatory agencies' missions is best served by becoming more and more facilitators for educating the public and enabling the public to own the issues and make decisions.

Washington state's technical review committee is a useful tool for many of the same reasons as these county-level advisory committees. Although evaluations could be done in-house, by regulatory agencies, giving power to these advisory committees enfranchises representatives from a variety of sectors of the community. Thus, the community becomes invested in the project. David Lenning reports that this arrangement sometime results in unusual situations, such as realtors appearing to advocate public health more strongly than public health officials.

A group of citizens representing over fifteen civic associations in the watershed of ***Waquoit Bay, Massachusetts*** have been working with the Citizens for the Protection of Waquoit Bay, the Association for the Preservation of Cape Cod, and the Waquoit Bay National Estuarine Research Reserve to draft an action plan for the watershed in order to protect and restore the natural resources of the bay. The action plan includes promoting the use of nitrogen-removal onsite wastewater treatment systems in the watershed and designating the watershed as a demonstration area for these systems.

Who is Working on This Problem in Massachusetts?

The Massachusetts Executive Office of Environmental Affairs (EOEA) is developing a review process for alternative technologies that is intended to complement DEP's existing program for permitting alternative wastewater treatment systems.

The TriTown Groundwater Protection District on Cape Cod, which has a management and inspection system in place, is interested in serving as a demonstration area for advanced systems in Massachusetts.

The Association for the Protection of Cape Cod (APCC) is promoting the use of advanced onsite wastewater treatment systems to protect natural resources and simultaneously create opportunities for small businesses. APCC is also co-coordinating the Waquoit Bay Citizen Action Committee, which is requesting the designation of the Waquoit Bay watershed as a demonstration area for nitrogen-removal onsite wastewater treatment systems.

The Cape Cod Commission (CCC) is particularly interested in facilitating the inclusion of advanced onsite technologies to achieve sound comprehensive planning. Using some of the Commission's innovative regulatory tools, it may be possible to establish special districts where, for example, new development and redevelopment projects must install advanced onsite wastewater treatment systems both on their own parcels and neighboring parcels.

The Department of Environmental Management (DEM) is working to use composting systems in selected state parks and forests.

The Department of Environmental Protection has a staff person, funded through EPA's non-point source pollution program, to review applications for alternative onsite wastewater treatment systems. The DEP recently approved the installation of two experimental Bioclere systems in Yarmouth.

The Waquoit Bay National Estuary Research Reserve (WBNERR) continues to serve as an information clearinghouse for advanced onsite work in Massachusetts. It is also especially interested in the possibility of using the Waquoit Bay Watershed, which is the subject of intensive hydrological and ecological study, and which drains to a hypersensitive embayment, as a demonstration area for advanced onsite wastewater treatment systems.

The city of Gloucester is working to install a variety of advanced systems to meet their wastewater treatment needs on the North Shore.

The Buzzards Bay Project is installing two or three demonstration systems in the town of Fairhaven.

The New England Interstate Water Pollution Control Commission is develop guidelines that would facilitate the exchange of information and evaluation of systems across state boundaries.

Every citizen who asks for a variance to install one of these systems or who helps to educate people in his or her community about the problems with conventional septic tanks and central sewers and the potential for advanced decentralized systems is playing an invaluable role.

IV - LOOKING TO THE FUTURE - CONCLUSIONS FROM THE MEETING

Where Do We Need to Go From Here?

(A Report from the Working Groups.[26])

We need to **establish comprehensive educational programs** about wastewater treatment and onsite wastewater treatment options in particular. We need to educate as many people as possible that the myth that conventional septic systems are adequate to protect public health and the environment in all situations is just that - a myth. In these situations, the particular siting of a system within a recharge area or watershed is neither an issue nor a solution. These systems do little to remove nitrogen from wastewater, and in much of southeastern Massachusetts the high nitrogen concentrations in the effluent lead to degradation of groundwater and estuaries. Educational programs need to include information on the impacts of nitrogen loading on health and the environment.

Equally important, we must convey the message that solutions to the problems which stem from using inappropriate wastewater treatment technologies must come in the context of comprehensive, logical planning.

Third, the educational effort must include the message that advanced onsite wastewater treatment systems are viable tools to use as part of the solution and that decentralized wastewater treatment systems can have significant environmental and economic advantages over large centralized systems. These programs should include hard data on advanced onsite wastewater treatment systems and information on what is required to operate and/or maintain different system types.

Educational programs should be addressed at towns, vendors, municipal boards, researchers, system users, and state, regional, and federal agencies.

We need to **encourage research programs** in advanced onsite wastewater treatment systems and innovative technologies, and in infrastructure development for these systems. This means providing funds for this research and development, following the example of places like Wisconsin and Florida. Similarly, we need more small-scale prototype projects to optimize the effectiveness of existing technologies for particular situations and effluent parameters (e.g. nitrogen removal).

Research and education needs to include **demonstration programs**. Demonstration systems will allow engineers to optimize nitrogen removal capabilities of different system types in different environments. They will also afford citizens and local regulators the opportunity to view these systems operating and being installed.

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[26] Each working group produced lists of recommendations; this section is culled from those lists.

We need to **overcome institutional barriers to change**. This means implementing appropriate positive and negative incentives to facilitate the use and further development of advanced technologies. It also means creating a proactive rather than reactive framework, which includes strong education and lobbying efforts. An example of a proactive community program could be the creation of an annual award, presented to an organization for outstanding education efforts about onsite wastewater treatment.

We need to **create a regulatory climate that fosters innovation**, that asks for a better mouse trap. This could include actions by the state of Massachusetts such as:

- Incorporating knowledge about nutrient loading and its impacts into state wastewater treatment codes.
- Promulgating legislation like the Wisconsin Groundwater Law (requires drinking water quality effluent) and the Pennsylvania Clean Streams Law.
- Fostering cooperative agreements between state agencies, as in the Washington Island project.
- Establishing grant programs like the Wisconsin Fund for the replacement of failed standard systems with innovative systems.
- Removing regulatory and bureaucratic barriers to innovation (e.g. excessive permitting requirements and filing fees for variances for innovative technologies) while retaining regulations necessary to protect the environment and public health.
- Making a commitment to actively support communities that take the lead in establishing reasonable maintenance and oversight programs.
- Drafting procedures to enable third party maintenance of advanced onsite wastewater treatment systems.
- Reducing siting restrictions for systems that produce high quality effluent.
- Implementing clear, stable, and reasonable (national ?) performance standards.
- Establishing a date by which existing systems in areas where a higher level of treatment is required to protect water quality would have to be replaced by advanced systems.
- Taxing the use of current technology, or providing tax credits, based on the environmental impacts of the particular technology.
- Creating tax incentives to capitalize revolving loan funds with private capital.
- Enabling towns to apply for revolving loan funds garnered and administered by the state.
- Deciding upon events that will trigger an enforced upgrade requirement.
- Clarifying the expectations of the state for allowing individuals or communities to install advanced onsite wastewater treatment systems.
- Establishing databases that allow comparisons of technologies, associated costs, and environmental benefits.

- Following Wisconsin and Washington in implementing a performance based regulatory code that would allow flexibility and long-range comprehensive planning.
- Assembling case studies/models of onsite management of advanced onsite wastewater treatment systems.
- Requiring operating permits for all onsite wastewater treatment systems, with associated inspections and fees. The fees could be directed to a special fund for appropriate disbursement.
- Establishing a process for the effective and timely evaluation, operation and management of new systems.

We need to **recognize that management is a critical issue but not one that is insurmountable**. Management strategies should include periodic inspections of systems and methods for ensuring the continued safe operation of these systems. The management and oversight process, and the associated operation and maintenance programs, may differ from the initial stages, where a municipality has ten or twenty of these systems, to the later stages, where advanced onsite wastewater treatment systems become widely used. We should therefore **consider a phased approach**, where we anticipate future needs and implement management programs (e.g. hiring of new staff, establishment of public-private partnerships, implementation of mandatory pumping schedules) as needed. This includes "gaming out" future scenarios to determine, for example, how much revenue would be generated by different funding mechanisms and how much would be needed by associated management scenarios (e.g. to pay additional board of health agents). It also includes focusing on the cost and methods for retrofitting existing onsite wastewater treatment systems.

We should **separate comprehensive planning and wastewater treatment/disposal regulations**. Comprehensive planning efforts (and associated land use decisions) should include the **identification and protection of natural resources** threatened by current or future excesses of nitrogen loading. This entails delineating recharge areas and conducting buildout scenarios. It should also include establishing higher water quality standards for receiving waters and wetlands.

In all these steps, we should **look to existing models from around the country**.

We need to create infrastructure that will foster cooperation on all levels from the homeowner to the National level. This would allow more resources, more sharing of information, and greater consistency.

In Massachusetts, What is My Part in Getting There?

As a Homeowner:

- Educate yourself about nitrogen loading and advanced onsite wastewater treatment systems. Reading this document is a great start!

- Consider installing an advanced onsite system at your home or business, either as a retrofit to your old system, or as a new system especially if your existing system needs to be replaced.
- Attend meetings of your local board of health, and encourage them to consider using these systems as part of a comprehensive planning effort by the town.

It is the perception of the regulatory agencies that, historically, individual homeowners have been neither aware of their responsibilities to maintain conventional systems properly, nor capable of proper maintenance and operation of more sophisticated systems. Communities that can convince regulatory agencies that the community can and will take responsibility for these systems, and for ensuring that new members of the community take responsibility for their systems, will be making a great contribution to this effort.

As a Small Business Owner:

- Consider installing an advanced system at your business.
- Consider what business opportunities the widespread use of advanced onsite wastewater treatment systems might present for you, and work with local and regional planning and health agencies to expand your business.
- Request that appropriate governmental agencies provide necessary educational materials to enable you to utilize appropriate technologies.

As a Representative on the Board of Health:

The Massachusetts DEP feels that, considering the potentially large number of systems involved, their permitting, surveillance, and enforcement capabilities would be overwhelmed. Therefore, the Department states that it would have to rely, once again, on local boards of health, although DEP recognizes that these local boards are also often understaffed, or local wastewater management districts for management and oversight.

DEP writes: "It will be the local boards of health or the local sewer district that permits the use of alternative technologies in their town, to ensure that the installation is according to all state and local regulations in addition to the manufacturers specifications. The local board of health would have to keep an inventory of all systems installed in town, ensure that they are properly maintained and if they are not, maintain the systems and bill the homeowner. In situations where a community system is proposed to serve a number of individual homes, the board of health must also look into the legal issues concerning ownership of the communal system and assessing user fees. Either an association with infinite life should exist such as a condominium association or the system should be deeded to the town, perhaps through a local sewer district. In both situations the town has to ensure that adequate reserve funds exist to cover possible costly repairs as well as eventual system replacement. Either a bond should be posted or revolving fund should be established."

Clearly, there are administrative agencies and opportunities for private sector involvement not addressed in this informal statement. However, the statement does convey DEP's expectation of oversight and responsibility, which, in many cases, will fall to the board of health.

Board members and health agents should:

- Determine which geographic areas within your jurisdiction are critical resource areas. This will allow local boards to prioritize areas for the use of advanced onsite wastewater treatment systems and to consider encouraging the use of nitrogen removal onsite wastewater treatment systems in those areas. Areas likely to receive high priority are recharge areas to wells impacted by high nitrogen levels and drainage basins to eutrophic embayments (characterized by excessive algae growth, eelgrass declines, and sometimes fishkills).

  Marine embayments that do not exhibit signs of eutrophication still require the board's attention. Simply because a particular embayment does not currently receive sufficient nitrogen inputs to create eutrophic conditions does not mean that eutrophication will never occur. Past, present and future development continue to increase the total amount of nitrogen entering coastal waters. As important and powerful parts of community government, Boards of Health should play a role in protecting waters that have not yet shown signs of excessive nitrogen loading.

- Work with neighboring towns to establish a coordinated plan for protecting critical resource areas. Often, the land area that drains to a coastal water body falls within the jurisdiction of more than one town. To protect the natural resource, it is necessary to address land use in the drainage area, which requires that towns work together.

- Learn about systems that currently exist which would meet your established performance criteria.

- Write a proposal to DEP for installing and managing new systems; convince DEP that you are serious about management and oversight, that you want to work with them, and that you have a good plan.

- Play an active part in reshaping current policy to meet the needs of the future.

- Establish and implement programs for inspection and maintenance of existing systems.

- Document locations of sub-standard systems and force upgrades to advanced systems.

- Become fully trained in the design and operation of advanced onsite wastewater treatment systems.

As a Conservation Agent:

Educate yourself further regarding new technology and how that technology relates to conservation. Then, be an educator to the public; encourage homeowners to apply the right system for their needs. Act as a regulatory check point with other local environmental agencies to be sure the systems that get put in are monitored so as to not cause more damage to the environment. Work cooperatively with homeowners and Boards of Health.

As a Planning Board Member:

One of the major fears frequently expressed about the use of advanced onsite wastewater treatment systems is the potential for the development of currently unbuildable land. As discussed above, from the view of environmental planning, this is also an asset because it allows for dense clusters and the simultaneous preservation of open space. Planning boards need to take an active role in thinking ahead to how zoning and development procedures might change in response to the availability of these systems. In particular, planning boards can take the initiative in working out these problems in close cooperation with health boards and conservation commissions, which will undoubtedly begin receiving requests for variances based on the availability of these technologies.

As a Selectman:

- Pass bylaws to delineate environmentally sensitive areas.
- Require performance standards in environmentally sensitive areas.
- Establish funding sources for inspection and maintenance programs for onsite wastewater treatment systems.
- Require the installation of advanced onsite wastewater treatment systems for all repairs or upgrades to public facilities such as schools. Establish these facilities as educational demonstration areas.

As a Legislator:

Draft and support legislation which will help fund the research and implementation of innovative wastewater treatment systems. Commission task forces to perform the economic and technical analyses necessary to convince people of the environmental and economic effectiveness of alternative technologies.

As a Funding Agency for Marine/Estuarine Research:

Give special consideration to proposals that specifically propose to use advanced onsite wastewater treatment technologies to restore and protect marine and estuarine ecosystems. Include the purchase and installation of such equipment as legitimate budget line-items in the context of estuarine research.

MESSAGES FROM THE MASSACHUSETTS EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS AND DEPARTMENT OF ENVIRONMENTAL PROTECTION

Secretary Susan Tierney

(The comments below are based on remarks delivered by Secretary Tierney at on Thursday, February 27th at the WBNERR conference.)

"Massachusetts Law...is geared toward conventional septic systems, which...do little for nutrients....I welcome this conference as an opportunity to jump into the fore of the efforts to solve this problem [of inadequate wastewater treatment and nutrient loading] in natural resource protection.

DEP has wisely proceeded with caution in the area of alternative wastewater technology because we have been faced with a tremendous workload and prefer to proceed with caution in order to risk being less than fully responsible to our other mandate which is to protect the public health.

A major stumbling block to using on site systems has been the implications for land use.

Technical solutions may already exist within innovative and alternative on site systems. At this time, we have no program to review and evaluate these systems, some of which are already working in other states. That, however, will change. Massachusetts should initiate an innovative and alternative on site system demonstration program to evaluate various technologies for existing residential structures....I believe such a program would have the potential to address a real environmental problem and support economic recovery for tourism, and fishing while promoting the development of the environmental technology industry.

Controlling non-point source pollutants

There is a broad consensus in the science and management communities that excess nutrient inputs, particularly nitrogen, can cause adverse impacts to drinking water and surface waters.

Innovative land use and growth management programs should be pursued, as should small community-based wastewater treatment plants.

One real option which you will be addressing here is decentralized wastewater treatment with nitrogen-removing onsite wastewater treatment systems.

I believe that there is a growing consensus among the wastewater treatment community that onsite wastewater treatment systems can do much better that traditional septic tank-leach field combinations....It is clear that the private sector can produce effective technologies in this area if it is given the necessary encouragement. Massachusetts has an opportunity available to be at the forefront of a national movement towards decentralized wastewater treatment using innovative technologies and regulatory strategies.

The main stumbling block to implementing these systems is no longer the technologies but rather the necessary operation, maintenance, and oversight programs.

The age of large, centralized wastewater treatment facilities, although they have played a crucial and valuable role in past decades, is coming to a close.

We here in Massachusetts are in accord with the majority of forward-thinking wastewater treatment managers, researchers, and engineers who agree that a decentralized approach is far more effective, economical, and appropriate."

Commissioner Daniel Greenbaum

(The comments below are based on remarks delivered by Commissioner Greenbaum on Friday, February 28th at the WBNERR conference.)

DEP has done a reasonably good job with protecting fresh water bodies, but we have never focused as much as we should on keeping pollutants from getting into coastal waters.

Regarding these technologies, I've seen them work. The issue, in my eyes, is not the theory of developing new technologies. Rather, the major challenge is to test them in the field and see the impact in the natural environment, in a wide range of settings.

Contrary to public perception, my department has responsibility for regulations and has in fact tested and approved a number of alternative technologies which are up and running. In many cases they work. The main question to answer is: are they easy to maintain, and are they reliable?

Please avoid the myth that alternative systems don't have land use impacts while sewers and conventional systems do. Too often the debate over alternative technologies becomes a land use debate, and we need to take that issue (land use) beyond wastewater treatment.

These technologies can be used, I think, and we're going to look for ways to use them. The issues we must confront, again, are: reliability, establishing a state-wide approval system which takes into account the systems' effectiveness in a wide range of settings, and the land use impacts of all the technologies under consideration.

This conference is extraordinarily timely with respect to the revisions of the Title 5 code.
We will look at elements of the Title 5 code.
We will try and identify ways to get such advanced onsite wastewater treatment systems into the mainstream.

Brian Donahoe - Director, Division of Water Pollution Control

Mr. Donahoe advocated a humanist approach to problem solving, with people of different viewpoints addressing conflicts and working as a team.
He also commented that many people outside are not as well versed in the issues as those attending the conference and targeted education as a major need for overcoming real or perceived barriers.
One of his goals is a public awareness that: "Flushing the toilet affects the groundwater where I live, and there's an economic and environmental cost associated with it." This kind of understanding empowers people to move forward to do things. In this regard, he referred to an example from Halifax in which a community was trying to solve their wastewater problems because people in the city, like the residents of Washington Island, realized that it made sense and that they had to do it to protect their quality of life.

He gave the following information about Massachusetts' activity regarding the nitrogen loading problem:

1) He referred to the New England Interstate Water Pollution Control Commission (NEIWPCC) and Massachusetts' participation in this effort to try and meld knowledge in more cost effective ways.
2) DEP has been talking with DEM Commissioner Webber for six months, trying to find sites in Massachusetts that can be controlled. The aim is to find a way to set up and test some of these innovative systems where Commonwealth employees are watching and evaluating them.
3) There is an opportunity to test Clivus Multrums.
4) There is a solar composter DEM has used.
5) The pilot facility run by Ocean Arks/Ecological Engineering Associates in Harwich is going to the final piloting phase.
6) There are three sites in the state where composted sludge material is being applied to reed beds (*Phragmites*).
7) A plastic insert that fits inside septic tanks seems to have an effect on reducing nitrogen.
8) The RUCK system has gone through an evaluation process and can be installed with a variance.
9) He remarked on wetland polishing systems.
10) DEP has an easier time with sand filters than with some other systems for which there is less information.

Title 5 systems are the minimum code; local communities have the right to suggest advanced systems. The typical method of doing so is to require setbacks further from shore (100 or 200 feet rather than 50 feet). Bylaws suggesting different sorts of systems are uncommon.

The state has also have approved RBC (rotating biological contactor) units (not individual but larger ones). They have a good performance basis from which to talk about RBC units.

Mr. Donahoe then explained some of his concerns.

In the aftermath of Hurricane Bob, he had opportunity to say Title 5 does not include cesspools. He spent a lot of time trying to get this point across. In general, the reaction from homeowners was: "no, we won't do it (i.e., upgrade our systems).

Moving those systems to Title 5 is a step in right direction.[27] Now, we may have an opportunity to upgrade them to nitrogen removal systems, and he wants to look into that further, addressing financial and management issues.

He also hopes a new version of the "cesspool memo" will go to health boards next week.

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[27] Editor's note: while upgrading cesspools to title 5 systems may seem like a positive step, it could in fact slow the process of moving to advanced onsite systems. Once a new title 5 system is in the ground, the likelihood of the owner paying to retrofit it with a recirculating sand filter or peat filter goes down. Failed or substandard systems provide an opportunity to leap immediately to advanced onsite systems, which, unlike title 5, may be adequate to protect the natural resources of the coastal zone.

Appendix A

Agenda from WBNERR Nitrogen Removal Onsite Wastewater Treatment Systems Conference

Thursday, February 27

8:00 - 8:30 Registration and Refreshments.

8:30 - 9:00 **Welcome and Introductory Remarks.**
Noel Gurwick Waquoit Bay National Estuarine Research Reserve
Peter Webber Commissioner
Massachusetts Department of Environmental Management
Susan Tierney Secretary
Massachesetts Executive Office of Environmental Affairs

9:00 - 9:40 **Outlining the Problem: the Impacts on Estuaries of Nitrogen from Increasing Numbers of Conventional Septic Systems.**
Dr. Jonathan Garber EPA Environmental Research Laboratory, Narragansett

9:40 - 10:00 **The Environmental Challenges for Nitrogen Removal Systems.**
Tom Cambareri Cape Cod Commission

10:00 - 11:45 **Available Nitrogen Removal On-Site Technologies.**
Steve Dix National Small Flows Clearinghouse
Dick Otis Ayres Associates

11:45 - 1:00 Lunch.

1:00 - 2:45 Panel Discussion:
Permitting & Managing Alternative Systems - Case Histories I:
Moderator - *Tom Groves* New England Interstate
Water Pollution Control Commission

1:00 - 2:20 **Presentations**
Kevin Sherman Florida Environmental Health Program
Mark Richardson California-Stinson Beach County Water District (tentative)
Ken Meyer Maine Division of Health Engineering
Randy May Connecticut Department of Environmental Protection

2:20 - 2:45 Questions and Discussion

2:45 - 3:15 Break

3:15 - 5:15 Panel Discussion:
Permitting & Managing Alternative Systems - Case Histories II:
Moderator - *Tom Cambareri* Cape Cod Commission

3:15 - 4:25 **Presentations**
David Lenning State of Washington
Thurston County Department of Environmental Health
Michael Corry Wisconsin Department of Industry, Labor, and Human Relations
John Murtha Pennsylvania Department of Environmental Resources

4:25 - 5:15 - Questions and Discussion

5:15 Adjourn Until Friday Morning

Friday, February 28

7:45 - 8:15 Refreshments Available.

8:15 - 8:30 **Introductory Remarks.**
Daniel Greenbaum Commissioner
Massachusetts Department of Environmental Protection

8:30 - 11:00 **Regulatory and System Proponent Perspectives on On-Site Regulation.**
Moderator - *Steve Dix* National Small Flows Clearinghouse

8:30 - 8:45 Setting the stage *Steve Dix*

8:45 - 9:15 **Regulators' Presentations**

Bryant Firmin	Massachusetts Department of Environmental Protection, Division of Water Pollution Control
Kevin Sherman	Florida Environmental Health Services Section

9:15 - 10:15 **Proponents' Presentations**

Donna Briesemeister	Washington Island Project Coordinator
Michael McGrath	Southeast Ruck Systems
David Dow	Action Energy/North Gloucester Villages Association
Joan Brooks	University of Maine, Department of Civil Engineering

10:15 - 11:00 Questions and Discussion

11:00 - 12:30 Lunch

12:30 - 2:15 Panel Discussion
**Nitrogen Management in a Broad Perspective:
Regional Planning, Economic, and Educational Concerns.**
Moderator - *George Heufelder* Barnstable County Health and Environment

12:30 - 1:45 - **Presentations**

Land Use Planning: Controlling Housing Density Without the On-Site Rule
John Witten Horsley, Witten, and Hegemann

Encouraging the Use of Permitted Alternative Systems
Margo Fenn Chief Planner, Cape Cod Commission

The Economic Benefits of Managing Nitrogen in Marine Environments

Yoshiaki Kaoru	Center for Marine Policy, Woods Hole Oceanographic Institution

Financing the Use of Innovative and Alternative Systems

Scott Horsley	Horsley, Witten, and Hegemann

The Need for State-Town Cooperation in Facilitating the Use of Innovative and Experimental Systems

Brian Donahoe	Massachusetts Department of Environmental Protection, Division of Water Pollution Control

1:45 - 2:15 - Questions and Discussion

2:15 - 2:45 Break

2:45 - 4:00 **Group work sessions**
Each group will have a moderator and a recorder.
The primary goal will be to:
(1) Summarize key points of previously presented information.
(2) Produce position statements identifying avenues for facilitating the use of these technologies to reduce nitrogen loading to groundwater and surface water bodies.

4:00 - 5:00 Panel Discussion

Technologies and Regulatory Strategies: Current Status and Future Needs.
Moderator - *Bruce Tripp*, Woods Hole Oceanographic Institution Coastal Research Center

Moderators from breakout groups will present their summaries.
Key points of agreement and obvious information/program gaps will be identified.

5:00 Conference Adjourns

DISPLAY AREA IS LOCATED IN THE CHAPEL.

PLEASE KEEP FOOD AND DRINKS EITHER OUTSIDE OR IN THE MAIN CONFERENCE ROOM. THEY SHOULD NOT BE TAKEN INTO BREAKOUT ROOMS OR THE EXHIBIT AREA.

NO SMOKING PERMITTED INSIDE THE CENTER

Appendix B

The Nitrogen Cycle

Nitrogen, a key component of many biologically important molecules, occurs in a number of forms, some of which are available to plants and/or animals. Through physical and biological processes, these various forms of nitrogen transform from one to another, forming a complex linkage of reactions known as the nitrogen cycle.

The most basic components of this cycle form the basis of our understanding of how nitrogen impacts coastal waters and of how onsite wastewater treatment systems do/do not remove nitrogen from the wastewater.

The majority of the atmosphere is nitrogen gas (N_2), which is unavailable directly to plants and animals. N_2 can be converted to NO_3, which is available for uptake by plants, which use the nitrogen to build biologically essential molecules such as proteins and nucleic acids. Animals obtain nitrogen by eating plants or other animals. When plants and animals die, bacteria break down these complex biological molecules, and the nitrogen is released as ammonium (NH_4^+), which is again available to plants or bacteria.

In the presence of oxygen, some bacteria convert NH_4^+ to NO_3 (nitrification). Under anaerobic (oxygen-free) conditions, some bacteria convert NO_3 (nitrate) to N_2 (nitrogen gas), a process known as denitrification. So, in order to achieve denitrification, it is first necessary to achieve nitrification. This requires aerobic followed by anaerobic conditions. Since septic tanks are largely anaerobic, and lack the aerobic-anaerobic sequence, they do not achieve much denitrification.

Appendix C

Contacts for Advanced On--Site Systems Information in Different States and for Technical Expertise

Connecticut	Randy May	DEP, Water Bureau	165 Capital Ave	Hartford	CT	6106	(203) 566 7049
Florida	Kevin Sherman	HRS Environmental Health	1317 Winewood Blvd	Tallahassee	FL	32399-0700	(904) 488-4070
Gloucester	David Dow	N. Gloucester Villages Assoc	1102 Washington St	Gloucester	MA	1930	(508) 281-3902
Land Use Planning	John Witten	Horsley, Witten, Hegemann	3179 Main Road	Barnstable	MA	2630	(508) 362-5570
Maine	Ken Meyer	Dept of Human Services; Hlth Engineering	State House Station , 10	Augusta	ME	4333	(207) 289-5684
Massachusetts	Bryant Firnmin	Mass. DEP, Water Pollution Control	1 Winter Street, 7th Floor	Boston	MA	2108	(617) 292-5500
New England	Tom Groves	NEIWPCC	85 Merrimac Street	Boston	MA	2114	(617) 367-8522
Nitrogen Biogeochemistry	Jonathan Garber Richard Voyer	U.S. E.P.A. Narragansett Environmental Research Laboratory	27 Tarzwell Drive	Narragansett	RI	02882	(401) 782-3018
North Carolina	Steve Steinbeck	NC Dept of Env, Health, and Natl. Res .	P.O. Box 27687	Raleigh	NC	27611-7687	(919) 733 2895
Onsite Engineering	Richard Otis	Owen Ayres Associates	2445 Darwin Rd	Madison	WI	53704	(608) 249-0848
Peat Filter Technology	Joan Brooks	University of Maine, Boardman Hall	Dept of Civil Engineering	Orono	ME	4469	(207) 581-2182
Pennsylvania	John Murtha	Department of Environmental Resources	Bureau of Water Quality Mgmt. . PO Box 2063	Harrisburg	PA	17105-2063	(717) 787-8184
Stinson Beach, CA	Mark Richardson	Stinson Beach County Water District	3605 State Rt # 1	Stinson Beach	CA	94970	(415) 868-1333
Washington	Dave Lenning	Thurston County Env Health	2000 Lakeridge Dr SW	Olympia	WA	98502	(206) 786-5455
Washington Island	Donna Briesemeister	Washington Island Project Coordinator	Route 1, Box 39	Washington Island	WI	54246	(414) 847 2330
Wisconsin	Michael Corry	DILHR, Administrator, Safety and Bldgs	201 E Washington Ave, PO Box 7969	Madison	WI	53707	(608) 266-1816

Waquoit Bay National Estuarine Research Reserve (WBNERR)
PO Box 3092
Waquoit, MA 02536
(508) 457-0495

National Small Flows Clearinghouse
Box 6064
West Virginia University
Morgantown, WVA 26506-6064
(800) 624-8301

Appendix D

Massachusetts DEP's Official Position on Alternative Systems

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of
Environmental Protection

William F. Weld
Governor
Daniel S. Greenbaum
Commissioner

December 10, 1991

Noel Gurwick
Waquoit Bay National Esturine Research Reserve
P.O. Box 92 W
Waquoit, Massachusetts 02536

Dear Mr. Gurwick:

The Division of Water Pollution Control recognizes the intense pressure many of the Commonwealth's natural resources are experiencing as the result of the encroachment of development. Development has occurred in many instances without adequate consideration afforded to the combined effects of development related activities on these resources. Of particular concern to the Division are the environmental impacts of current waste disposal practices in overdeveloped lakeshore and embayment areas. Therefore, the opportunity presented by this conference on Denitrifying On-site Waste Disposal Systems Technologies and Regulatory Strategies is one in which the Division is excited to be an active participant.

As a regulatory agency, the Division must have full knowledge of the problems to be addressed; the possible resolutions; and their technical, legal, financial and environmental impacts in order to act responsibly within the constraints of the existing regulatory framework. I am confident that the information provided by this conference will benefit the Division in its efforts to help reduce the nutrient loadings to our lakes and embayments. The following discussion is intended to present a brief overview of the Division's perspective on the permitting and use of effective nutrient reduction in terms of the existing regulatory process.

The Massachusetts Clean Water Act (M.G.L.c.21, s.26-53) was amended by Chapter 246 of the Acts of 1973 to authorize the Division of Water Pollution Control to regulate all water of the Commonwealth, including ground waters. Discharges to ground are regulated by the Division under Title 5 of The State Environmental Code: Minimum Requirements for the Subsurface Disposal of Sanitary Sewage (310 CMR 15.00) and the Massachusetts Ground-Water Discharge Permit Program (314 CMR 5.00). These two sets of regulations establish minimum design and/or treatment requirements. Title 5 contains

One Winter Street • Boston, Massachusetts 02108 • FAX (617) 556-1049 • Telephone (617) 292-5500

primarily siting and design criteria for the use of on-site individual residential sewage disposal systems, commonly referred to as septic systems, which are designed to accept a flow of 15,000 gallons per day (gpd) or less. The Division has delegated authority to administer Title 5 to local boards of health but retains approval authority over variances to the code and the use of systems which are not specifically described in the code. The latter situation includes the use of alternative systems such as community septic systems and more sophisticated systems than the conventional septic tank/soil absorption system.

The Massachusetts Ground-Water Discharge Permit Program regulates all discharges to ground with a design flow in excess of 15,000 gpd. Permitted facilities must be custom designed to provide a minimum of secondary wastewater treatment and routine effluent and ground-water quality monitoring is required. The Division is the review and permitting authority for such facilities in consult with the local boards of health.

In cases where individual homes or limited groups of homes require on-site sewage disposal, septic systems can be effective when designed, sited, installed, operated and maintained properly. In the proper environmental setting and with proper management septic systems can provide a safe and reliable method of sewage treatment and disposal, especially in areas of relatively low population density where public sewer is not available. However, conventional septic systems may not be appropriate for sewage disposal in certain soil types and under some environmental conditions. Non-conventional systems may provide improved treatment capabilities in some situations. But with generally more complex systems come the increased opportunities for error in design, installation and operation.

The Division has recently completed a detailed technical review of Title 5 to assess the provisions of the code with respect to research in subsurface sewage treatment and disposal conducted since the code was last revised in 1978. The report, prepared by an independent consultant, clearly documents the importance of proper siting in achieving minimal adverse environmental impacts from the use of septic systems. The importance of maintaining a healthy biological mat in the disposal area and aerobic conditions below the mat cannot be understated. The report recommends that in order to achieve optimal treatment, the existing Title 5 criteria should be revised. What this would mean is that the required land area for disposal would be increased. For new construction, required land area can easily be planned for. However, existing homes may not have adequate land area available to site a new or replacement system. This will undoubtedly continue to be a difficult problem in attempting to reduce pollutant loadings in environmentally sensitive areas.

Some overly-developed areas, most notably around lakes and marine embayments, are now experiencing an excessive number of failures, especially among those systems which predate Title 5 design standards. Additionally, in these environmentally sensitive areas systems which are in compliance with Title 5 may not be adequate. The inability of conventional septic systems to reduce nitrogen may result in unacceptable levels of this nutrient reaching sensitive receptors via the ground-water. Coupled with high septic system density these areas pose severe long-term threats to the public health and the environment. These areas are characterized by high concentrations of nitrate-nitrogen, bacteria and viruses and significant amounts of organic contaminants in the ground and surface waters.

There are basically three (3) options available to reduce unacceptable pollutant loadings in environmentally sensitive areas - (1) extension of publicly owned treatment works (POTW) sewer to the area; (2) construction of limited sewer to serve the specific area with connection to a small wastewater treatment facility (permitted under 314 CMR 5.00); and (3) employment of individual or clustered alternative on-site treatment/disposal systems (permitted under Title 5). In most cases, the POTW option is not economically viable in isolated areas. Sewering small areas (option #2) and utilizing alternative technologies (option #3) offer economic advantages to the users and environmental benefit but raise serious concerns to the regulators.

Title 5 currently restricts the use of alternative systems and prohibits the use of subsurface sewage disposal systems for multiple lot and cluster development, unless the municipality assumes ownership and responsibility for the long-term operation and maintenance of the system. To date, very few communities have been willing to make this commitment.

In the case of alternative systems, the primary benefit of a conventional septic system is its simplicity and ease of operation. Alternative systems may provide an additional level of treatment of wastewater but generally they also require additional operation and maintenance and expertise that the average homeowner does not possess. Therefore, in addition to a more detailed technical review careful consideration must be given to the routine maintenance and inspection requirements of the system as well as the attendant financial obligations of the homeowner.

Small privately owned treatment facilities (PSTF's) offer the opportunity to provide very high levels of wastewater treatment and the potential advantage to locate the discharge in a less environmentally sensitive area or remove it from the watershed entirely.

In environmentally sensitive areas where increased treatment is desirable, community septic systems and multiple lot alternative systems and PSTF's should be considered. However, as with the individual alternative systems, adequate financial and legal assurances must be in place before such systems can be approved.

Clearly, the critical concerns of the Division with all of these system options relate to the long-term legal responsibility of the public or private ownership entity to ensure continued proper operation and maintenance which includes financial capabilities and an appropriate contingency plan should the system fail. Not all of the concerns can be adequately addressed under existing statutes, (eg Homeowners Association - M.G.L.c.184) or regulations. The municipality is currently the only legal entity which can allay most of these concerns. Therefore, in the absence of revisions to establish an alterative mechanism(s) to provide such assurances, the municipal officials must be willing to become active participants in a process or processes which will lead to a homeowner/municipal partnership in abating the impacts to these areas.

Very truly yours,

Brian Donahoe

Brian Donahoe
Director

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection

William F. Weld
Governor
Daniel S. Greenbaum
Commissioner

April 1, 1992

Noel Gurwick
WBNERR
P.O. Box 3092
Waquoit, MA 02536

Dear Noel,

As promised, here is a list of the alternative/experimental systems approved in Massachusetts:

1. **Zabel Filter.** This filter fits on the outlet tee of a septic tank and prevents the solids from entering the drain field. It's use in Massachusetts was approved subject to conditions in 1991. A number of the filters have been installed in Pembroke.

2. **Ekofinn Bioclere.** This is a trickling filter, secondary treatment unit that is installed in-line between the septic tank and the leaching field. The Division has recently approved two experimental/demonstration installations in South Yarmouth.

3. **Ruck Systems.** This system uses a combination of an aerobic sand filter and an anaerobic upflow filter to remove nitrogen and phosphorous from the wastewater. It is approved for use in Massachusetts through the provisions of Title 5 for miscellaneous disposal. The only installation thus far is in East Falmouth.

4. **Geo-flow.** This system replaces the conventional leaching field with a perforated pipe wrapped in a geotextile fabric. Recently, the Division approved one experimental/demonstration installation of this system in the Southborough Town Hall.

I hope you find the above information helpful. If you have any questions please do not hesitate to call.

Very truly yours,

Christos Dimisioris

One Winter Street • Boston, Massachusetts 02108 • FAX (617) 556-1049 • Telephone (617) 292-5500

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
**Department of
Environmental Protection**

William F. Weld
Governor
Daniel S. Greenbaum
Commissioner

April 28, 1992

Noel Gurwick
WBNERR
P.O. Box 3092
Waquoit, MA 02536

Dear Noel,

In response to your recent inquiries on recirculating sand filters the Division of Water Pollution Control reiterates its willingness to allow a limited number of systems to be installed in any of the Towns of the Commonwealth provided that:

1. The local Board of Health approves its use in writing.

2. Final design plans and specifications stamped and signed by a Massachusetts Registered Professional Engineer including data from deep observation hole and percolation testing conducted in the proposed disposal and reserve area, shall be submitted to the Division's Boston Office for approval.

3. Approval of the experimental system shall be for the recirculating sand filter. All other requirement's of 310 CMR 15.00 shall be satisfied in the design and construction of the proposed system.

4. A monitoring plan and schedule, including the frequency of sampling, parameters to be monitored, methodology to be used, and the duration of testing, shall be submitted to the Division for review and approval prior to operation of the system. Since there has been extensive research done on recirculating sand filters the Division feels that one test before construction and a limited number after the system has been operating and its effluent quality has been stabilized will be sufficient.

5. All data obtained from the testing of the experimental system shall be submitted to the Division's Boston Office, and the local Board of Health.

6. Written confirmation of the local Board of Health of their commitment to review the data reports and inspect the experimental system on a regular basis shall be submitted to the Division.

8. A Septage Handler licensed by the local Board of Health in accordance with G.L.c. 111 s. 31A and 310 CMR 15.02 (3) must service the system and pump the septic tank regularly - at least once every two years. It is the owners responsibility to report in writing to the local Board of Health every time the septic tank is serviced to ensure compliance with this condition.

9. Should the experimental system fail or show signs of imminent failure, as determined by the Division, the owner shall immediately remove the experimental system and take all steps necessary to replace the disposal system with one which meets the requirements of 310 CMR 15.

Should you have any questions regarding this mater, please contact Christos Dimisioris of my staff at (617) 292-5912.

Very truly yours,

Brian Donahoe

Brian Donahoe
Director
Division of Water Pollution Control

sand.001

cc: Cape Cod Commission

Appendix E

Excerpts from a Sample Agreement, with Monitoring Requirements, for an Experimental System in Massachusetts

I - Excerpt from a letter to Brian Donahoe, Director of DEP Water Pollution Control from Thomas W. Joy, P.E., of the Coastal Engineering Company, Inc.. The letter was an application for approval "to install and use an innovative sewage disposal system" at a Super Stop & Shop in South Yarmouth, Massachusetts under 310 CMR 15.18 (1). The letter was dated February 14, 1992, and the system has since been installed.

"The 'innovative' sewage disposal system proposed is a trickling filter treatment unit as manufactured by Ekofinn Bioclere, Inc. which will be used in conjunction with the proposed subsurface sewage disposal system. The Bioclere Unit will be installed in-line between the septic tank and pump chamber to provide secondary treatment of the wastewater stream. As the enclosed drawings indicate, after receiving primary treatment in the septic tank, the sewage effluent will flow by gravity into the Bioclere Unit where it will be lifted to the top of the trickling filter via a pump. The effluent will then flow downward through the filter media and then either be recycled to the septic tank or flow by gravity to the pump chamber for distribution to the subsurface leaching facility. The only mechanical systems involved for the Bioclere are the lift pump(s) and a fan to provide oxygen for the aerobic treatment. In the event that the pump(s) which lifts effluent to the top of trickling filter fails, the wastewater will flow through the Bioclere Unit, and the septic system will still function as a conventional Title 5 system.

It is the intent of this study to provide documentation to the Department of the effectiveness of the Ekofinn Bioclere Wastewater Treatment System in reducing BOD_5, Total Suspended Solids, Ammonia, Nitrate Nitrogen and Phosphorus. To that end, we are proposing a comprehensive testing, monitoring, and evaluation plan as follows:

Sampling and Analysis

Influent and effluent samnpling will be conducted at the 21,000 gallon septic tank outlet and pump chamber inlet, respectively. Groundwater sampling will be conducted from a series of five (5) monitor wells....Sampling protocol for all monitor wells will be as follows:

> -Static water level and total well depth will be obtained and total standing volume of water will be calculated.
>
> -At least three (3) times the standing volume of water will be purged by bailing, by power driven pump, or by the use of a hand pump.

-In-situ readings of specific conductivity will be ontained intermittently during the purging process. The well will be considered adequately purged after a stable reading is obtained, ensuring that the sample is representative of formation water.

-After purging the well, all required samples will be bailed and placed in cleaned, autoclaved glass containers.

-After collection, samples wil be immediately placed in an iced cooler, before proveeding to the next well.

-Once all samples are gathered, all the equipment will be cleaned according to standard field protocol (to avoid cross-contamination between wells). This process includes an initial rinsein a mild detergent solution, a rinse in distilled water, a rinse in 10% chlorine solution and a final rinse in distilled water.

-A field log will be kept for each sampling trip with accurate field conditions, in-situ readings, and notations alerting the laboratory of any possible sampling problems which might affect accuracy of analysis or might explain discrepancies.

Similarly, influent and effluent samples will be collected by a bailer with the same decontamination and handling practices.

Table 1 below shows the water quality parameters to be analyzed by Envirotech Laboratories of Sandwich in accordance with methodologies currently certified by the Commonwealth of Massachusetts for both influent/effluent and groundwater samples.

Table 1: Water Quality Analysis

	Conductivity	Suspended Solids	BOD-5	Nitrate-N	Ammonia-N	TKN	Oil/ Orease	Phosphorus
Influent/ Effluent	X	X	X	X	X	X	X	X
Groundwater	X		X	X	X	X	X	X

Prior to installation of the Bioclere Unit, a series of three (3) groundwater samples will be collected to establish background water quality data. Upon start up of the treatment unit, sampling will be weekly for the first month, monthly for the following six (6) months and quarterly thereafter."

The letter granting Mr. Joy's request, subject to certain conditions, follows.

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection

William F. Weld
Governor
Daniel S. Greenbaum
Commissioner

March 24, 1992

Thomas W. Joy, P.E.
Coastal Engineering Co.
260 Cranberry Highway
Orleans, MA 02653

RE: Proposed Innovative Sewage Disposal System
Mercury Drive, South Yarmouth, MA
Transmittal Number 15319

Dear Mr. Joy:

The Division of Water Pollution Control has reviewed your January 31, 1992 letter and accompanying plans requesting the Department's approval to install and use a trickling filter sewage treatment unit as manufactured by Ekofinn Bioclere, Inc. in conjunction with the existing subsurface sewage disposal system at the above referenced location.

The Department hereby approves the request subject to the following conditions:

1. Prior to construction the South Yarmouth Board of Health must approve its use and a written confirmation of their commitment to inspect the system and review the quarterly data reports shall be submitted to this office.

2. Written consent of the owner to allow officials of the South Yarmouth Board of Health and employees of the Division, access to inspect the system as needed.

3. A Septage Handler licensed by the local Board of Health in accordance with G.L.c. 111 s. 31A and 310 CMR 15.02 (3) must service the system and pump the septic tank regularly - at least once every two years. It is the owners responsibility to report in writing to the South Yarmouth Board of Health every time the septic tank is serviced to ensure compliance with this condition.

4. Prior to use, a maintenance agreement with a qualified person or company shall be submitted to this office. The name and telephone number of this

person must be posted on or near the alarm system. It is the responsibility of this person or company to maintain an inventory of high wear parts on site.

5. In addition to the parameters proposed in the testing protocol, the samples collected will be analyzed for Fecal Coliform. Also, the final report should include the energy and maintenance costs.

6. Should the experimental system fail or show signs of imminent failure, as determined by the Division, the owner shall immediately remove the experimental system and take all steps necessary to replace the disposal system with one which meets the requirements of 310 CMR 15.

Should you have any questions regarding this matter, please contact Christos Dimisioris of my staff at (617) 292-5912

Very truly yours,

Brian Donahoe
Director
Division of Water Pollution Control

CD Ekofinn.001

cc: South Yarmouth Board of Health
DEP, DWPC, SERO

Appendix F

List of Technical Advisors and Reviewers

Robert Bailey, WBNERR Education Advisory Subcommittee
Donna Briesemeister, Washington Island Project
Joan Brooks, University of Maine
Tom Cambareri, Cape Cod Commission
Michael Corry, Wisconsin DILHR
Christos Dimisioris, Massachusetts Department of Environmental Protection
Stephen P. Dix, E.P.A. National Small Flows Clearinghouse
Brian Donahoe, Massachusetts Department of Environmental Protection
David Dow, North Gloucester Villages Association
Ed Eickner, Cape Cod Commission
Margo Fenn, Cape Cod Commission
Bryant Firnmin, Massachusetts Department of Environmental Protection
Jonathan Garber, US EPA Narragansett Environmental Research Laboratory
Christine Gault, Waquoit Bay National Estuarine Research Reserve
Tom Groves, New England Interstate Water Pollution Control Commission
George Heufelder, Barnstable County Department of Health and Environment
Scott Horsley, Horsley, Witten, & Hegemann
Yoshiaki Kaoru, WHOI Center for Marine Policy
Randy May, Connecticut DEP
John Murtha, Pennsylvania Department of Environmental Resources
Dick Otis, Ayres Associates
Mark Richardson, Stinson Beach County Water Management District
Ted Rowan, WBNERR Education Advisory Subcommittee
Beth Schwarzmann, WBNERR Education Advisory Subcommittee
Kevin Sherman, Florida HRS Environmental Health
Margaret Sloan, Association for the Preservation of Cape Cod
JoAnne Sulak, US EPA Region I.
John Witten, Horsley, Witten, & Hegemann

Appendix G

Excerpt from North Carolina Administrative Code
Matrix of Technologies, Permit Requirements, and Minimum System Review Frequency

.1961 MAINTENANCE OF SEWAGE SYSTEMS

(a) Any person owning or controlling the property upon which a ground absorption sewage treatment and disposal system is installed shall be responsible for the following items regarding the maintenance of the system:

(1) Ground absorption sewage treatment and disposal systems shall be maintained at all times to prevent seepage or discharge of sewage or effluent to the surface of the ground or to surface waters.

(2) Ground absorption sewage treatment and disposal systems shall be checked, and the contents of the septic tank removed, periodically to ensure proper operation of the system.

(b) System management in accordance with Tables V(a) and V(b) of this Rule shall be required for all systems installed or repaired after July 1, 1992. After July 1, 1992, system management in accordance with Tables V(a) and V(b) shall be required for all existing Type V and Type VI systems.

(1) After July 1, 1992, no Improvement Permit shall be issued for Type IV, Type V, or Type VI systems, unless a management entity of the type specified in Table V(b) is specifically authorized, funded, and operational to carry out this management program in the service area where the proposed system is to be located.

(2) A local health department may be a public management entity for systems classified Type IV, V(a) and V(b) only when specifically authorized by resolution of the local board of health.

(3) A contract shall be executed between the system owner and a management entity prior to the issuance of an Operation Permit for a system required to be maintained by a public or private management entity. The contract shall include the specific requirements for maintenance and operation, responsibilities of the owner and system operator, provisions that the contract shall be in effect for as long as the system is in use, and other requirements for the continued proper performance of the system. It shall also be a condition of the Operation Permit that subsequent owners of the system execute such a contract.

(4) Inspections of the system shall be performed by a management entity at the frequency specified in Table V(b). The management entity shall report the results of their inspections to the local health department at the specified reporting frequency. However, where inspections indicate the need for system repairs, the management entity shall notify the local health department within 48 hours in order to obtain an Improvement Permit for the repairs.

(5) The management entity shall be responsible for assuring routine maintenance procedures in accordance with the conditions of the Operation Permit and the contract.

(6) Sewage systems with multiple components shall be classified by their highest or most complex system type in accordance with Table V to determine local health department and management entity responsibilities.

(7) Sewage systems not identified in this Rule shall be classified by the Division of Environmental Health after consultation with the appropriate commission governing operators of pollution control facilities.

(8) The local health department shall routinely review the performance and operation reports submitted in accordance with Table V(b) of this Rule and shall perform an on-site inspection of the systems as required in Table V(a).

(9) Nothing in this Section shall preclude any requirements for system operators imposed in accordance with Article 3 of G.S. 90A.

TABLE V(a)

LOCAL HEALTH DEPARTMENT RESPONSIBILITIES

System Classification	System Description	Permits Required	Minimum System Review Frequency
Type I	a. Privy b. Chemical toilet c. Incinerating toilet d. Other toilet system e. Grease trap	Improvement Permit and Operation Permit	N/A
Type II	a. Conventional septic system (single-family or 480 GPD or less) b. Conventional septic system with 750 linear feet of nitrification line or less c. Conventional system with shallow placement	Improvement Permit and Certificate of Completion	N/A
Type III	a. Conventional septic system > 480 GPD (excluding single-family residence) b. Septic system with single effluent pump or siphon c. Gravity fill system d. Dual gravity field system e. PPBPS system, gravity dosed f. Large diameter pipe system g. Other non-conventional trench systems	Improvement Permit and Operation Permit	5 yrs.
Type IV	a. Any system with LPP distribution b. System with more than 1 pump or siphon	Improvement Permit and Operation Permit	3 yrs.
Type V	a. Sand filter pretreatment system b. Any > 3,000-GPD septic tank system with a nitrification field designed for > 1500 GPD c. Aerobic Treatment Unit (ATU) d. Other mechanical, biological, or chemical pretreatment plant (< 3000 GPD)	Improvement Permit and Operation Permit	12 mos.
Type VI	a. Any > 3,000 GPD system with mechanical, biological, or chemical pretreatment system plant b. Wastewater reuse/recycle	Improvement Permit and Operation Permit	6 mos.

TABLE V(b)

MANAGEMENT ENTITY RESPONSIBILITIES

System Classification	Management Entity	Minimum System Inspection/Maintenance Frequency	Reporting Frequency
Type I	Owner	N/A	N/A
Type II	Owner	N/A	N/A
Type III	Owner	N/A	N/A
Type IV	Public Management Entity With a Certified Operator or a Private Certified Operator	2/yr.	12 mos.
Type V (a) & (b)	Public Management Entity With a Certified Operator or a Private Certified Operator	a. 2/yr (0-1500 GPD) 4/yr (1500-3000 GPD) 12/yr (3000-10000 GPD) 1/wk (> 10000 GPD) b. 12/yr (3000-10000 GPD) 1/wk (> 10000 GPD)	6 mos.
(c) & (d)	Public Management Entity With Certified Operator	c. 4/yr. d. 12/yr.	
Type VI	Public Management Entity With a Certified Operator	a. 1/wk(3000-10000 GPD) 2/wk(10000-25000 GPD) 3/wk(25000-50000 GPD) 5/wk(> 75000 GPD) b. 12/yr.	3 mos.

(c) A sewage collection, treatment, and disposal system that creates or has created a public health hazard or nuisance by surfacing of effluent or discharge directly into ground water or surface waters, or that is partially or totally destroyed shall be repaired within 30 days of notification by the state or local health department unless the notification otherwise specifies a repair period in writing. If a system described in the preceding sentence has for any reason been disconnected, the system shall be repaired prior to reuse. The state or local health department shall use its best professional judgement in requiring repairs that will reasonably enable the system to function properly. If, for any reason, a sewage collection, treatment, and disposal system is nonrepairable, the system shall not be used.

(d) When necessary to protect the public health, the state or local health department may require the owner or controller of a malfunctioning system to pump and haul sewage to an approved sanitary sewage system during the time needed to repair the system.

History Note: Filed as a Temporary Amendment Eff. July 3, 1991,
for a Period of 180 Days to Expire on December 30, 1991;
Filed as a Temporary Amendment Eff. June 30, 1990,
for a Period of 180 Days to Expire on December 27, 1990;
Statutory Authority G.S. 130A-335(e) and (f);
Eff. July 1, 1982;
Amended Eff. August 1, 1991; October 1, 1990; January 1, 1990; August 1, 1988.

.1962 APPLICABILITY

The provisions of this Section shall not apply to properly functioning sewage collection, treatment, and disposal systems in use or for which a valid permit to install a system has been issued prior to July 1, 1977. This provision is applicable only where the sewage flow and sewage characteristics are unchanged. This provision does not affect the requirements for system operation, maintenance, and management in accordance with Rule .1961 of this Section.

Appendix H

Selected References:

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